Parcels and the Cadastre

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ESRI
Modeling Our World II
Discovering geodatabase designs

Modeling Our World

Discovering geodatabase designs

This is a new ESRI book under development that contains a series of geodatabase data models solved for the GIS data modeler. The pages that follow contain draft content of a chapter of this book.

David Arctur
Michael Zeiler

May 7, 2003

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This chapter is focused on the presentation of a working parcel data model case study. It is designed as a practical model which builds on today's best GIS methods and practices. While this parcel data model case study is largely based upon the needs of U.S. counties, many of the key concepts are of practical use worldwide. In order to reach the broad parcel user community, we document here the thought processes and design decisions for this data model.

Walk into any local government building and you will find a multitude of maps draped on the walls—maps of jurisdictional boundaries, maps showing land use and zoning, maps used to delineate electoral districts, maps for managing environmental areas, maps of municipal utility service.

You will also see public sector staff using interactive map displays to assist property owners in performing the desired service. And citizens accessing all public data through map-based interfaces on the Internet.

Parcel maps are the cornerstone for how local governments manage and access information. Nearly all the information that flows through local governments contains a reference to a place: an address, a location, an area of land. The parcel is the basic unit of geography for local governments.

This parcel data model gives GIS professionals at local governments and other organizations a powerful start on the intelligent creation, mapping, maintenance, and analysis of parcel data. In this chapter, you will learn about cartographic practices for parcel maps, distinctions and issues for modeling different kinds of parcels, and the GIS database schema for parcels.

This chapter documents a GIS data model for land parcels that was developed by a consortium of interested agencies and individuals led by Nancy Von Meyer of Fairview Industries. This parcel data model was developed in conjunction with, and is an implementation that supports, the Federal Geographic Data Committee (FGDC) Cadastral Data Content Standard (FGDC, 1999). The chapter discusses both the general land parcel data model as well as an actual deployment of this schema at Oakland County in Michigan.

Parcels and the cadastre

Parcel maps are essential for government services and economic activity. Shown here are several tasks involved in creating new land parcels at a county government in the United States, from the time a subdivision of land is created to the sale of lots. Note that the department and agency names and tasks performed can vary among organizations. The departments and work flows described here are a generalization of a common process used in the U.S. for land division approval, recording, and maintenance.

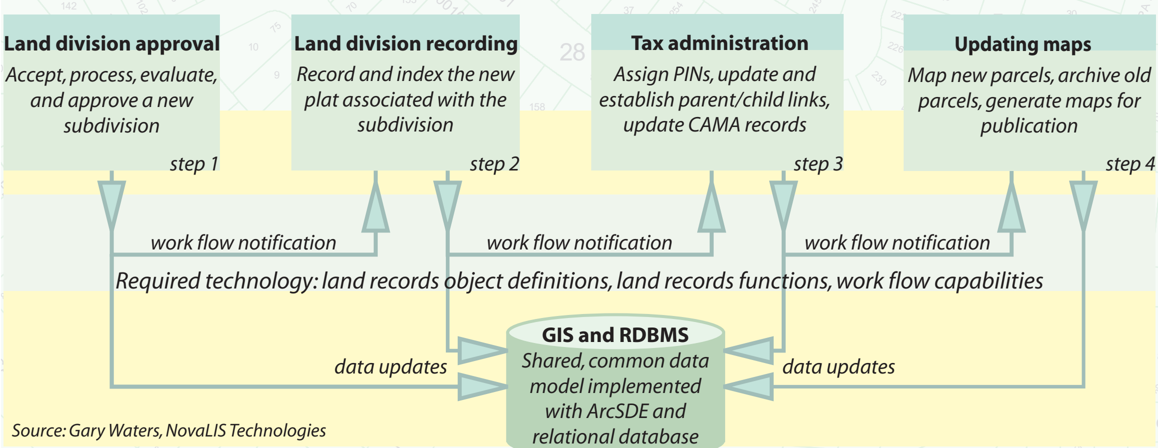
LAND DIVISION APPROVAL

Many departments at the local government level may play a role in accepting, processing, evaluating, and approving a new subdivision. These can be planning agencies, highway or transportation departments, zoning departments, regional authorities and even state agencies. These agencies work with developers, property owners, the public, and elected officials to formulate a subdivision document that can be submitted for approval.

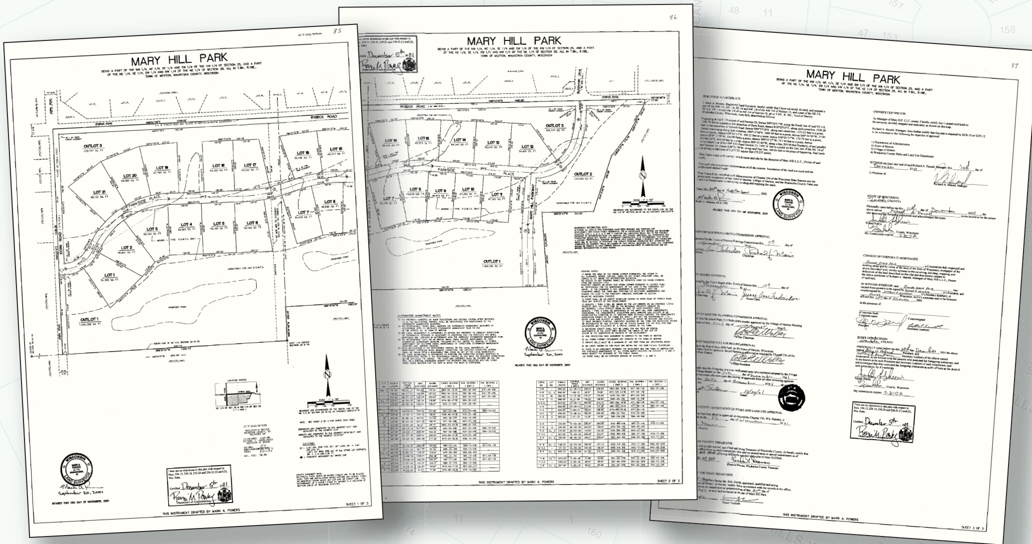
LAND DIVISION RECORDING

The Register of Deeds or County Recorder reviews the subdivision document for format and completeness. The subdivision document is recorded at a date and time and an index describing the document is prepared. The index commonly contains the grantor, which is the current owner, the grantee, which is the purchaser, the name of the subdivision, and general indication of the location of the subdivision. The subdivision location is often kept in a tract index, which facilitates searching for and finding recorded documents based on general location.

Business process **Establish new parcels**



The agencies listed here are typical departments of a county government responsible for these business steps; however, considerable variation does exist in the organization of county governments.



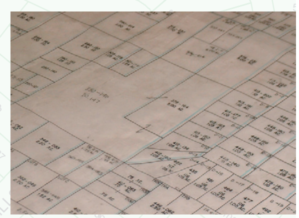
Subdivision plats courtesy of Waukesha County, Wisconsin

TAX ADMINISTRATION

The assessment agency, also called the real property department, the property tax department, or the tax lister department, generates and maintains the value and tax information about newly created parcels. This department assigns a parcel or tax identification number called the parcel identification number (PIN), or tax map sheet number (TMS). The parcel number associates a parcel's appraised value, tax value information, ownership, site addresses, and mailing addresses for taxation and mapping. In some jurisdictions the assessed value and taxable value are managed in a Computer Aided Mass Appraisal (CAMA) system. In terms of work flow, the final appraised and taxable values may be assigned on an annual or semiannual basis rather than on a per-transaction basis. The other important function of the parcel number and the parcel mapping is to manage the historical lineage of the parcels. This historical lineage is important for tracking real property taxes and land division status over time.

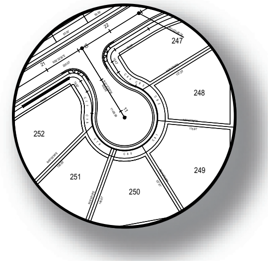
UPDATING MAPS

The Mapping Department is a generic title for a local government department/office that produces parcel maps. This mapping function may occur before the assessment process and involves mapping all land parcels onto the County or Township maps. The specifics of how the maps are organized into map sheets or files vary widely from place to place. The general process is to determine the location of the new subdivision, archive the parcels that were there, and replace them with the new parcels created by the subdivision. In some jurisdictions a graphical lineage of the parcel ownership is maintained with the mapping so that a graphical chain of title can be easily derived. The mapping department typically provides maps to other departments and to post on the agency's Web site, or generates hardcopies and associated reports for the public and other users.



Using parcel maps

Once parcel maps have been created, they can be used in numerous ways, such as for defining and working with rights and interests, land use zoning, public access areas, building permits, public works projects, and others. Understanding how parcel maps will be used in your own jurisdiction will help focus the database and system designs to best meet your needs. This section discusses just a few common applications.



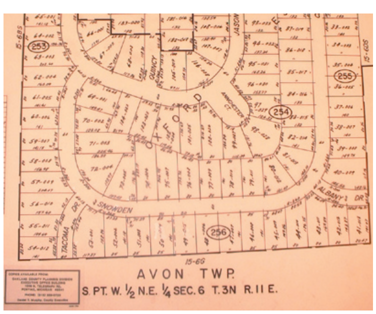
RESEARCHING TITLES

Once a parcel is recorded, entered into the assessment system, and mapped it becomes available for use by the public and other departments. One common use, as a complement to working with a grantor–grantee index, is to help research a title. This is a process of working through the chain of title from the current owner to each successive past owner until all the owners for a piece of land have been documented. The resulting document is sometimes called an abstract or an abstract of title. In some states these title searches go back 30 years in what is sometimes called a 30-year marketable title. In other states the full title is researched.

Title research is a commonly occurring task and the GIS can be very helpful in providing graphical support to the chain of title.

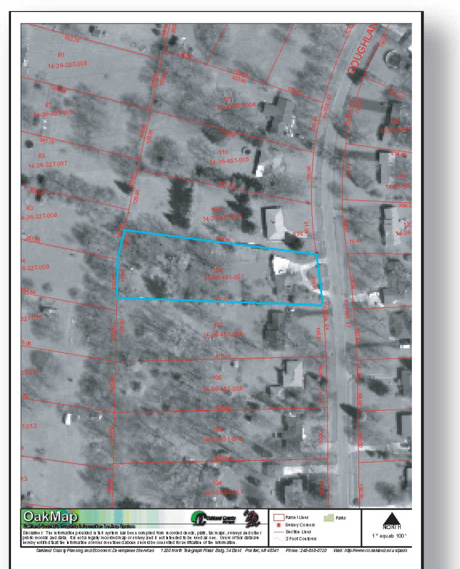
HISTORIC PARCEL MAPS

Historical parcel maps can support developing a chain of title but they are also important for establishing prior and historical land use, determining historical patterns of ownership and for supporting the initial automation of the parcel maps. In some areas these historical maps are scanned so that the original image of the map can be referenced. Many local governments are also storing historic aerial photography of their jurisdictions, which over time have become useful for environmental analysis and other research.



LOCATING CUSTOMER INFORMATION

The ultimate use of the parcel maps is to serve the government and its citizens. In any jurisdiction it is important to be able to find, retrieve, and present customer information. A customer can be a taxpayer, an elected official, a developer, another department, a state agency or anyone making a request for information. How customer information is located depends on how it is indexed. By linking information to the maps in a GIS, the tasks involved in determining the location of customer requests and finding information related to that request becomes easier and faster.



In Oakland County, Michigan, many local governments are now providing their citizens kiosks with simple but flexible tools to ask the most common types of queries, as well as hardcopy maps on demand for nominal fees.

EMERGENCY OPERATIONS

Parcel maps can be used to support emergency operations, fire and police operations, Homeland Security, and other critical government functions. For emergency operations, the parcel maps and their related data can provide access to landownership information, identifying the current owner, and determining whether there is a structure on the property and what type of structure it is.

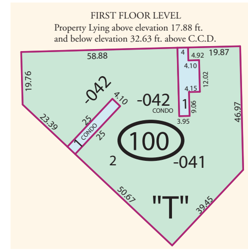
For example, police or fire officials may need to contact a commercial building owner if there is a fire at night or in the aftermath of a storm. The parcel maps, with their related information, can be very useful for determining damage assessments, conducting followup checks of neighborhoods and notifying landowners of remediation activities. The parcel information provides an important access point in times of emergencies for linking data from many sources. This is an increasingly urgent requirement, as the demands of responding to emergency situations are calling for greater integration and collaboration among all the local governments' GIS data holdings and services.

Public-sector uses for GIS

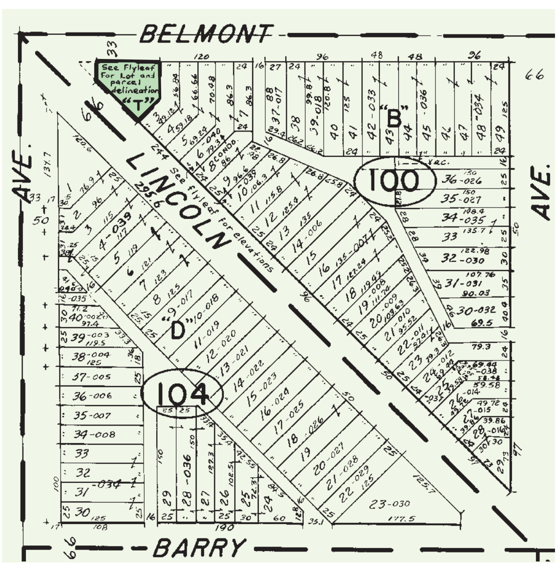
- Land use, urban growth planning, and permit tracking
- Economic development planning
- Infrastructure and transportation planning
- Infrastructure and transportation management
- Needs assessments and epidemiological analyses
- Legislative redistricting
- Crime tracking and law enforcement planning
- School districting and school bus routing
- Educational planning across secondary, university, and technical school levels
- Comparison of program effectiveness across jurisdictions
- Taxation analysis and record keeping
- Benchmarking in human services
- Public health risk analysis
- Site selection for service facilities, housing, and so on
- Site selection for locally unwanted land uses, such as landfills and prisons
- Emergency management
- Environmental monitoring, and wildlife and greenway corridor siting
- Public housing and housing weatherization and rehabilitation planning
- Public information systems

Source: John O'Looney, *Beyond Maps: GIS and Decision Making in Local Government*, ESRI Press, 2000

This topic covers some of the ways that data sources are transformed into parcel maps. These methods can be combined—Oakland County uses coordinate geometry supplemented with digital orthophotography. Data sources can vary greatly in accuracy and in automation cost. Methods that may be least expensive for initial compilation, such as vectorized maps and heads-up digitizing, can be the most expensive options for long-term maintenance, due to lower accuracy and resulting potential for extra work to resolve property description conflicts that arise in the normal flow of updating parcel maps.



There are several options for counties that are automating their hardcopy parcel maps for a GIS. To get the initial database constructed within a reasonable time and cost, they might digitize scanned maps or perform heads-up digitizing from orthophotos. However, for ongoing maintenance of the parcel automation, they may choose to improve the accuracy of the GIS data with COordinate GeOmetry (COGO) descriptions derived from surveys or legal descriptions, or with actual survey measurement data in the database.



Historic tax maps courtesy of Cook County, Illinois.

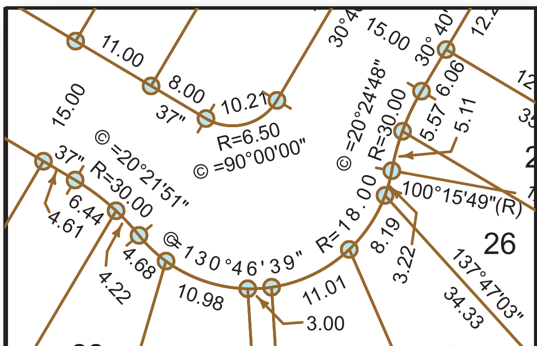
Each method varies considerably in terms of accuracy and cost. The potential error in digitized maps comes from many factors besides the accuracy of the original field measurements, such as the scale of the source map, stretching of the map, original drafting accuracy, digitizing accuracy, and others. In contrast, the accuracy of primary sources depends primarily on the survey measurements. The more accurate the data, the better suited it is to be integrated with other feature classes or map layers (*vertical integration*).

The use of COGO or other survey-based approaches implies different data models, such as COGO attributes on features, or survey datasets in the database. This level of sophistication is becoming increasingly important as communities and agencies seek to build "multipurpose cadastral systems where information about natural resources, planning, land use, land value and land titles, including Western and indigenous interests, can be integrated for a range of business purposes." *(Williamson and Ting, 1999)*

COORDINATE GEOMETRY DESCRIPTIONS

COGO is a computational method and, in modern times, a widely used software tool for parcel mapping. COGO transforms field survey measurements into accurate geographical positions. Legal property descriptions from deeds and title reports may be used, as well.

In the parcel data model, the Boundary feature class (discussed in a later section) has been made COGO-ready by including certain attributes to retain traverse data: Direction, Distance, Radius, Delta, Tangent, Arclength, and Side. These are used by COGO editing tools during polygon creation and updates.



Topology rules for use with COGO editing are straightforward: any feature classes that define the parcels and their boundaries would participate in the same topology. The COGO feature classes would have a higher accuracy rank than the other feature classes. This will be discussed in more detail in a later section on topology rules.

MEASUREMENT BASED CADASTRAL SYSTEM

Integrating direct land survey data with the GIS provides a way to achieve highly accurate tax maps. These could be CAD-based data converted to a GIS and georeferenced to the Public Land Survey System (PLSS) or other control network. For greatest accuracy, this approach would employ *cadastral adjustment* to reconcile differences between multiple surveys of the same points and lines. This is a mathematical process requiring actual survey field data. To take advantage of this approach, the survey information in the form of survey points, measurements, computations, and coordinates, would be linked to appropriate feature classes in the GIS, such that when an update to a survey occurs, these linked or survey-aware GIS features are also updated accordingly. (The ability to integrate survey data and define survey-aware feature classes depends on the GIS used.) Survey-aware feature classes would typically include TaxParcel, SimultaneousConveyance, Corner, Boundary, and possibly others, as discussed in later sections. When using survey data to update the GIS, some feature classes that might have been part of the GIS, such as Monuments and CornerCoordinates, are no longer needed since this data would be part of the survey dataset.

With the use of survey-aware feature classes, topology rules may be somewhat different. The survey-aware feature classes should all participate in the same topology. Furthermore, all feature classes that are in a topology with a survey-aware feature class must also be made survey aware.

Costs and benefits of methods for parcel map automation

	Vectorized maps	**Digitized orthophotos**	**Coordinate Geometry**	**Measurement-based cadastre**
Accuracy	Lowest *	Better	Good	Highest
Compilation cost	Lowest	Moderately higher	Much higher	Higher
Maintenance cost	Highest	Moderately lower	Lower	Lowest
Vertical integration	Poor *	Slightly higher	Good	Best
Benefits	Fast way to get started	Fast way to get started	Detect conflicts	Integrate GIS and legal

** Improves with quality of ground control network*

The collection of thematic layers shown here represent the key components of the conceptual design for the land parcel data model. Users often choose subsets of these layers to best support their available data and institutional practices. All these layers need not be within the user's authority to control, but could be drawn from other departments agencies, or elsewhere on the Internet.

Across different jurisdictions even within the same state or province, data collection and maintenance policies can vary widely. This model can be adapted to suit a wide range of institutional settings, while still providing strong unifying concepts that promote data sharing.

The parcel is the heart of the Federal Geographic Data Committee (FGDC) Cadastral Data Content Standard (FGDC, 1999) Cadastral Data Content Standard. This model has been developed to be consistent with the FGDC standard.

PARCEL THEMATIC LAYERS

The parcel model has seven key thematic layers as shown on the facing page. Starting from the bottom, the foundation layers are digital orthophotography, parcel frameworks, and corners and boundaries. Next, ownership parcels and tax parcels are the fundamental parcel information required by most jurisdictions. The top two themes, parcel related uses and the administrative areas, are derived layers for using parcel data with a local government.

Digital orthophotography represents the base spatial reference theme and is often used for heads-up digitizing of parcels.

Corner and boundary information is used to construct parcels. In some jurisdictions, corners and boundaries may precede the parcel framework, but the thematic content is the same—points and lines to build parcel polygons.

A continually maintained survey is often used to manage precise locations for corners and boundaries. Surveys are managed in a comprehensive survey dataset.

The parcel framework provides the supporting outline for parcel-related features. These are typically based on the boundaries of major subdivisions as defined by surveys. In the case of Oakland County, Michigan, and for a large portion of the United States, this is the Public Land Survey System.

Parcel and parcel framework boundaries can also include road and river networks. Transportation and hydrography are the subject of separate and extensive data modeling efforts, and are described in other chapters of this book. But in practice, parcel mapping often includes separate layers for these features.

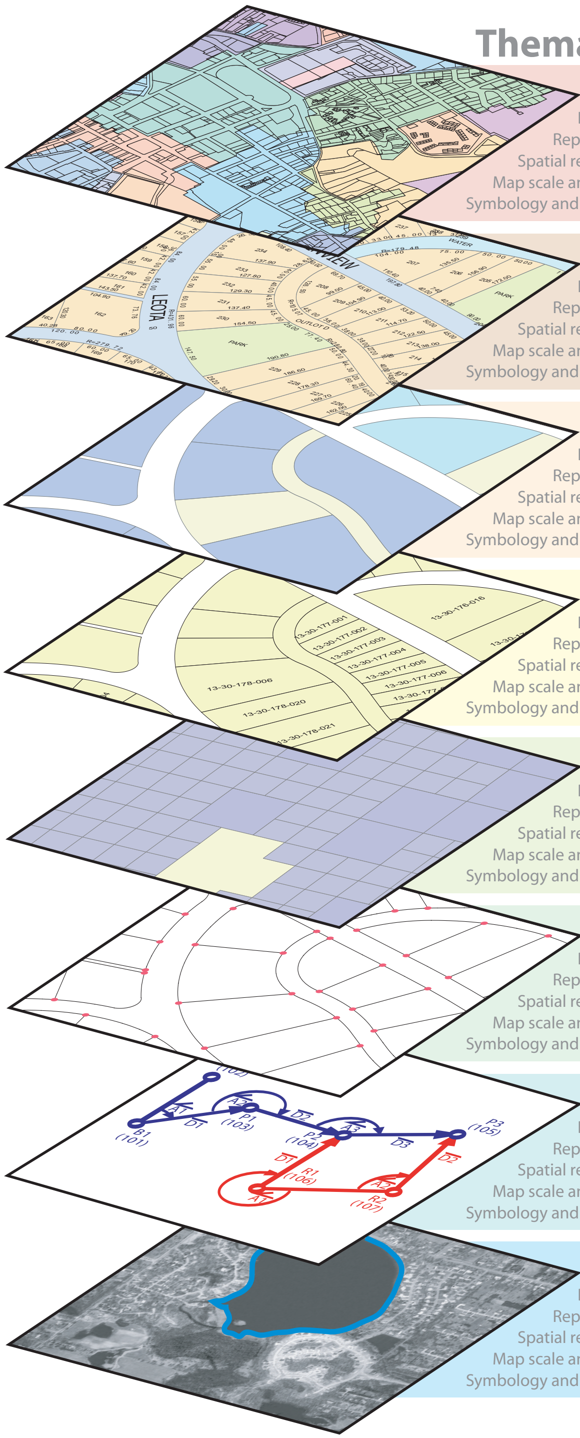
The ownership and tax parcel themes may have related tables that contain essential information for local government operations, such as tax rolls, condominium records, and grantor–grantee indices.

Parcel-related uses include managing land use, such as zoning or master plans, regulations on land, such as limits on building sizes, and parcel site addresses, which may be important for emergency management and public notification.

Administrative areas are the management and jurisdiction districts important to parcel management. Some examples are school districts, taxing authorities, sanitary districts and parcels included in lake management associations.

Together, these themes form the basis of parcel management systems that support ongoing activities in governmental bodies and decision making in all sectors.

Thematic layers of the parcel data model



Layer	**Administrative areas**
Map use	Tax administration and map production
Data source	Derived through dissolve operation or by known relationship to parcels
Representation	Polygons
Spatial relationships	Districts of the same type do not overlap
Map scale and accuracy	Scale is typically 1:1 200 to 1:4 800, accuracy varies
Symbology and annotation	District name and type by annotation

Layer	**Site addresses, regulated uses, and restrictions**
Map use	Identify address locations, extent of regulated uses, and restrictions
Data source	Derived from tax parcels and other sources
Representation	Points and polygons
Spatial relationships	Polygons may overlap, points are contained within polygons
Map scale and accuracy	Scale is typically 1:1 200 to 1:4 800, accuracy varies
Symbology and annotation	Regulated use by color, addresses annotated, restrictions by type

Layer	**Separated rights and encumbrances**
Map use	Identify rights, interests, and limitations on landownership
Data source	Derived from legal descriptions
Representation	Polygons
Spatial relationships	Separated rights, encumbrances are overlapping and noncontinuous
Map scale and accuracy	Scale is typically 1:1 200 to 1:4 800, accuracy varies
Symbology and annotation	Fills with transparencies can reveal polygon overlay patterns

Layer	**Ownership and tax parcels**
Map use	Identify extent of parcels for assessment and land management
Data source	Plats, condominiums, and surveys
Representation	Polygon
Spatial relationships	Tax parcels do not overlap
Map scale and accuracy	Scale is typically 1:1 200 to 1:4 800, accuracy varies
Symbology and annotation	Property identification numbers (PINs) annotated

Layer	**Parcel framework**
Map use	Boundary control and registration
Data source	Surveys, parcel control points
Representation	Points, lines, polygons, and survey dataset
Spatial relationships	Corners define PLSS shapes. Feature classes are all survey-aware.
Map scale and accuracy	Submeter to millimeter
Symbology and annotation	Corner type, accuracy, and method of collection annotated

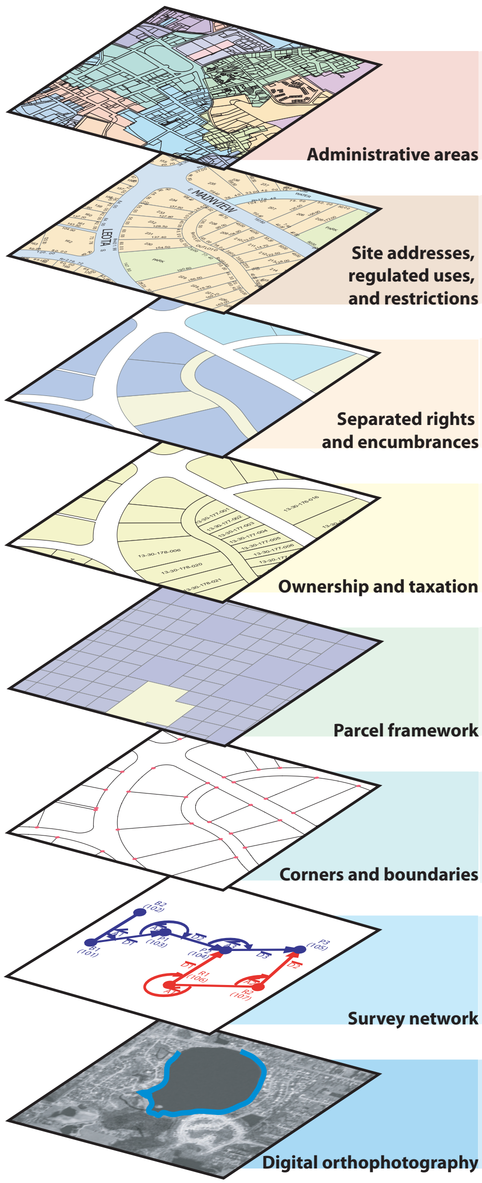
Layer	**Corners and boundaries**
Map use	Identify extent of land divisions
Data source	Plats, condominiums, and surveys
Representation	Lines and points, optionally stored in a survey dataset
Spatial relationships	Primary parcel features for an area
Map scale and accuracy	Scale is typically 1:1 200 to 1:4 800, accuracy varies
Symbology and annotation	Record dimensions, line types , and subdivision corners

Layer	**Survey network**
Map use	Foundation for a map's positional accuracy
Data source	Survey measurements and computations
Representation	Survey dataset
Spatial relationships	Controls locations of points in survey-aware feature classes
Map scale and accuracy	Exceedingly high accuracy
Symbology and annotation	Survey-aware point features shown with error ellipses

Layer	**Digital orthophotography and hydrography**
Map use	Map background and reference
Data source	Aerial photogrammetry and satellite collection
Representation	Raster and vector for hydrography
Spatial relationships	Pixels tesselate the area imaged, hydrography forms a boundary
Map scale and accuracy	Pixel resolution typically is 15 to 50 centimeters
Symbology and annotation	Tone, contrast, and balance of gray scale or color presentation

Decomposing the thematic layers

The thematic layers are mapped to the geodatabase structure. In some instances, several thematic layers combine to form a set of feature classes in a feature dataset, with integrity constraints in the form of topologies and geometric networks. In other instances, a thematic layer maps to a survey dataset, a raster dataset, or any georeferenced data source. Relationships bind features and objects, enable validation, and link behavior.



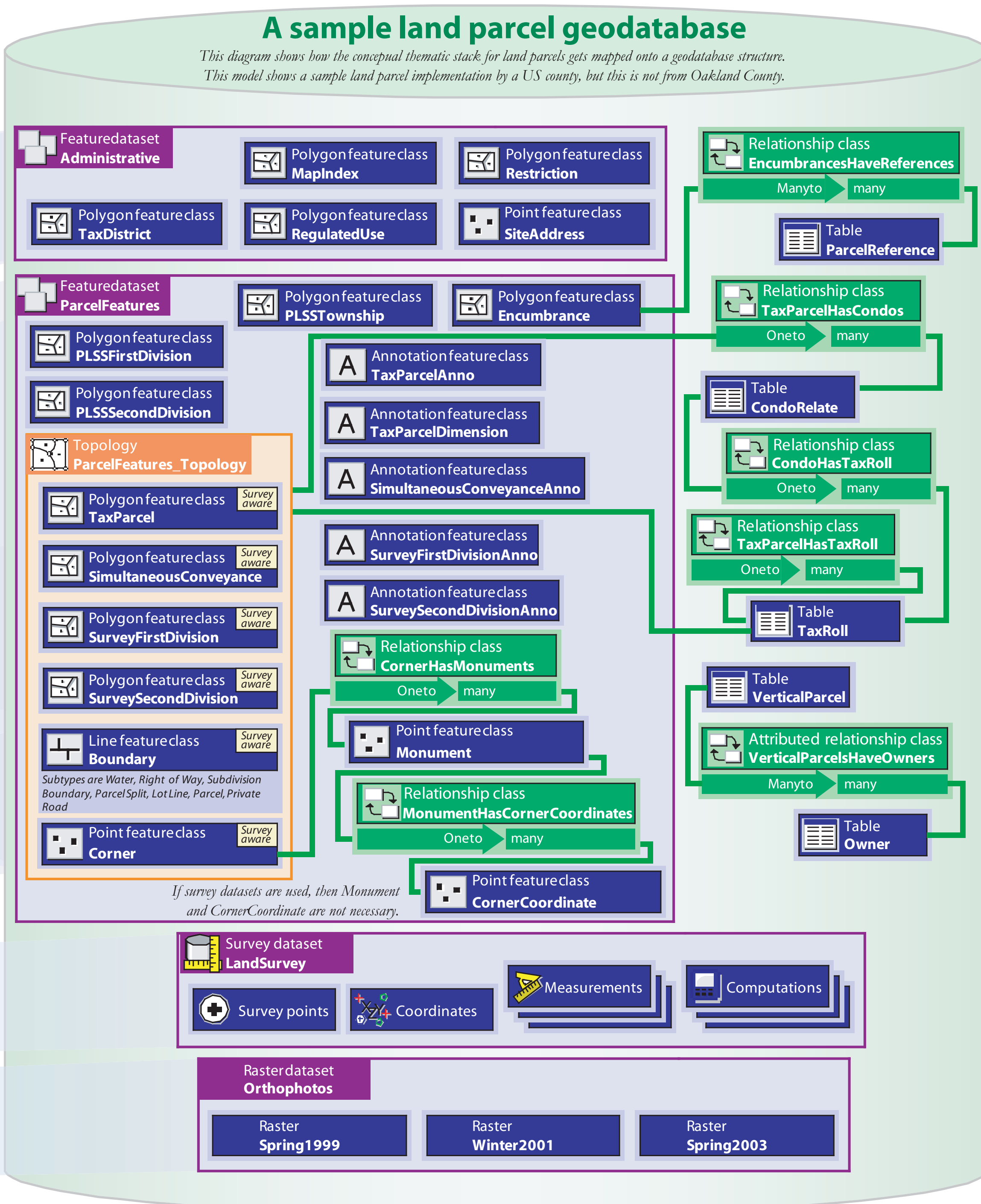
These thematic layers capture various ways of organizing parcels, plus other important information used in different maps. This data is derived from other features, for use by planners and other users.

The parcel features dataset provides a linkage between parcels and tax rolls. It also provides a connection between parcel boundaries and actual survey data. For spatial integrity, the features in this dataset are topologically integrated.

Feature classes for locating land parcels based on surveys and on the PLSS represent the cadastral framework theme.

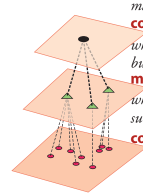
The survey dataset contains the survey points, measurements, computations, and coordinates that form the survey network, obtained from field surveys.

The raster data can be stored as a mosaic in a single database record, or as separate records in a table (one record per image source file).


A sample land parcel geodatabase
This diagram shows how the concepual thematic stack for land parcels gets mapped onto a geodatabase structure.
This model shows a sample land parcel implementation by a US county, but this is not from Oakland County.
Featuredataset Administrative
Polygonfeatureclass MapIndex
Polygonfeatureclass Restriction
Polygonfeatureclass TaxDistrict
Polygonfeatureclass RegulatedUse
Point featureclass SiteAddress
Relationship class EncumbrancesHaveReferences
Manyto many
Table ParcelReference
Featuredataset ParcelFeatures
Polygonfeatureclass PLSSTownship
Polygonfeatureclass Encumbrance
Polygonfeatureclass PLSSFirstDivision
Polygonfeatureclass PLSSSecondDivision
Relationship class TaxParcelHasCondos
Oneto many
Annotationfeatureclass TaxParcelAnno
Annotationfeatureclass TaxParcelDimension
Annotationfeatureclass SimultaneousConveyanceAnno
Table CondoRelate
Relationship class CondoHasTaxRoll
Oneto many
Topology ParcelFeatures_Topology
Polygonfeatureclass TaxParcel
Survey aware
Polygonfeatureclass SimultaneousConveyance
Survey aware
Polygonfeatureclass SurveyFirstDivision
Survey aware
Polygonfeatureclass SurveySecondDivision
Survey aware
Line featureclass Boundary
Survey aware
Subtypes are Water, Right of Way, Subdivision Boundary, Parcel Split, Lot Line, Parcel, Private Road
Point featureclass Corner
Survey aware
Annotationfeatureclass SurveyFirstDivisionAnno
Annotationfeatureclass SurveySecondDivisionAnno
Relationship class TaxParcelHasTaxRoll
Oneto many
Table TaxRoll
Relationship class CornerHasMonuments
Oneto many
Point featureclass Monument
Table VerticalParcel
Attributed relationship class VerticalParcelsHaveOwners
Manyto many
Relationship class MonumentHasCornerCoordinates
Oneto many
Table Owner
Point featureclass CornerCoordinate
If survey datasets are used, then Monument and CornerCoordinate are not necessary.
Survey dataset LandSurvey
Measurements
Computations
Survey points
Coordinates
Rasterdataset Orthophotos
Raster Spring1999
Raster Winter2001
Raster Spring2003

DRAFT—ESRI

In many jurisdictions the parcel maps begin with the definition of survey corners, followed by coordinate geometry or survey descriptions of the boundaries between them. Corners and boundaries also provide reference locations for the parcel framework. A local government may create a grid of surveyed monuments and other points throughout its jurisdiction to serve as a required reference grid for all property surveys. As in Oakland County, these reference corners can be co-located with the PLSS corners.



Relationship class
CornerHasMonuments

Type *Simple* — Forward label *Monument*
Cardinality *One To Many* — Backward label *Corner*
Notification *None*

Origin feature class	Destination feature class
Name *Corner* Primary key *CornerID* Foreign key *CornerID*	Name *Monument*

Relationship class
MonumentHasCornerCoordinates

Type *Simple* — Forward label *CornerCoordinate*
Cardinality *One To Many* — Backward label *Monument*
Notification *None*

Origin feature class	Destination feature class
Name *Monument* Primary key *CornerPointID* Foreign key *CornerPointID*	Name *CornerCoordinate*

Corners are point feature classes in this model, based on the FGDC Cadastral Data Content Standard (FGDC, 1999). In this standard the parcel is defined by legal descriptions. Parcels are the spatial extent formed by record boundaries and corners. The attributes for the corners and record boundaries, as described in the standard, are information from public records.

There are 22 types of corner features in the data model, although not all will be used in every situation. These include Township Corner, Closing Township Corner, Section Corner, Closing Section Corner, Center of Section, Quarter Corner, Closing Quarter Corner, Aliquot Part, Closing Aliquot Part, Crossing Closing Corner, Intersection Point, Location Point, Location Monument, Meander Corner, Special Meander Corner, Mile Post/Mile Corner, Point on Line, Witness Point, Other, and Unknown. Of these, the corners related to Township, Section, and Quarter are especially for PLSS. Aliquots are sometimes used as further divisions of PLSS quarter-sections and sometimes used independently of PLSS.

Corners are best managed through survey information. The construction methods used to establish coordinates on corners determine the parcel boundaries. These methods are cartographic construction, computations, and adjustments. The methods used to determine coordinates are important because they help assure coordinate accuracy when survey datasets are employed.

This parcel model accommodates multiple monuments for corners, and multiple coordinates for each monument. That is, a corner may be marked by more than one monument, and a monument may have more than one coordinate value. (The CornerCoordinates feature class is not needed when the Corners are integrated with a survey dataset; this information is maintained in the survey data.)

To make informed decisions about which coordinate to use in a GIS to represent a corner, it may be important to know the source and quality information of all coordinates and monuments. The FGDC Cadastral Data Content Standard (FGDC, 1999) addresses this issue. The attributes for corners, monuments, and coordinates in this parcel model are taken from the standard. The concept is to have GIS features that represent the physical realities of parcel corners and to capture sufficient information for complete parcel mapping. For example, notice the possible values for corner types listed above. The possible corner types support both simultaneous conveyances and the PLSS, to be discussed later in this chapter.

Note that the use of the Monument and CornerCoordinate feature classes is optional. If you choose to use survey projects to manage your surveyed points, then these two feature classes and related relationship classes are not necessary, as they are redundant with tables managed by ArcGIS™ Survey Analyst.

Simple feature class
Corner

Geometry *Point*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	OID						
Shape	Geometry	Yes					
CornerID	String	Yes					30
CornerType	String	Yes	Other	Corner-Classification			30
CornerLabel	String	Yes					100
CornerLocalLabel	String	Yes					60

A corner is a legal location. It may mark the extremity of parcel or a parcel framework polygon. A corner may have multiple monuments which serve as physical markers for the legal location of the corner.

Primary key for the feature class polygon.

A named corner classification.

A name describing the legal location. For PLSS, names for corners on base land net.

Any number of alternative names or aliases for the corner.

Simple feature class
Monument

Geometry *Point*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Precision	Scale	Length
OBJECTID	OID				
Shape	Geometry	Yes			
CornerPointID	String	Yes			30
CornerID	String	Yes			30
MonumentType	String	Yes			30
MonumentDateSet	Date	Yes	0	0	8
CPSourceAgent	String	Yes			100
CPSourceIndex	String	Yes			100
CPSourceType	String	Yes			100
CPSourceDate	Date	Yes	0	0	8
CornerPointStatus	String	Yes			100

A monument is a point feature which marks the ends of record boundaries or the extremities of a parcel or a parcel framework polygon. A corner may or may not be monumented and it is possible that there is only one monument per corner. The relationship allows for multiple monuments for corners.

A primary key for the point feature.

Pointer to the corner point feature to identify which corner the monument is attached to.

The type of source for the monument information.

Simple feature class
CornerCoordinate

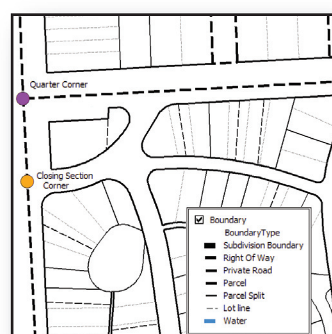
Geometry *Point*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	OID						
Shape	Geometry	Yes					
CornerCoordinateID	String	Yes					30
CornerPointID	String	Yes					30
XCoordinate	Double	Yes			0	0	
YCoordinate	Double	Yes			0	0	
ZCoordinate	Double	Yes			0	0	
CoordinateValue	String	Yes					30
CoordinateStatus	String	Yes	Active	CoordinateStatus			30
CSourceAgent	String	Yes					100
CSourceIndex	String	Yes					100
CSourceType	String	Yes					100
CSourceDate	Date	Yes			0	0	8
CSourceComments	String	Yes					100
XAccuracy	Double	Yes			0	0	
YAccuracy	Double	Yes			0	0	
ZAccuracy	Double	Yes			0	0	
Reliability	String	Yes					30
AccuracyComments	String	Yes					30
HorizontalDatum	String	Yes	NAD83	HorizontalDatum			30
CoordinateSystem	String	Yes					30
VerticalDatum	String	Yes	North American Vertical Datum of 1988	ElevationDatum			60
CoordinateMethod	String	Yes	Total Station	CoordinateMethod			30
CoordinateProcedure	String	Yes	Other	CoordinateProcedure			30
VerticalUnits	String	Yes	International Feet	ElevationUnits			30

The corner point measured coordinate is a (x,y), (x,y,z), or z value for a monument. Note that measured does not imply surveyed. Digitizing from a map is a type of measurement.

Primary key for the feature.

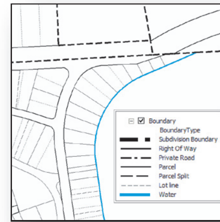
Points to the monument which the coordinate represents.



Corner and boundary map data courtesy of Oakland County, Michigan.

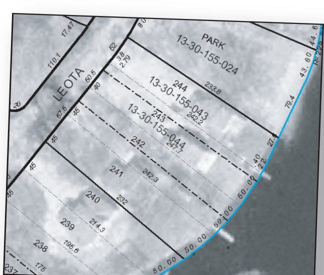
Boundaries

Boundaries are the exterior lines that form the parcel or parcel framework. In many jurisdictions, coordinate geometry and/or least squares adjustments are used to compute the shape and extent of parcels. The information for the coordinate geometry and adjustments are usually extracted from public records, such as plats, condos, or surveys.



Each parcel polygon and parcel framework polygon is built up from a set of distinct boundary line features. Boundary features have several attributes as shown in the adjacent figure. A jurisdiction can collect some or all of these attributes, depending on the construction method and what information is available. For example, some attributes apply only to curved line segments (e.g., Radius, Delta, Tangent, ArcLength, and Side) and are used for coordinate geometry (COGO) data. RecordDirection and RecordDistance are used for straight-line segments between two points, which may also be part of a COGO description. Any of the attributes can be used for boundary annotation.

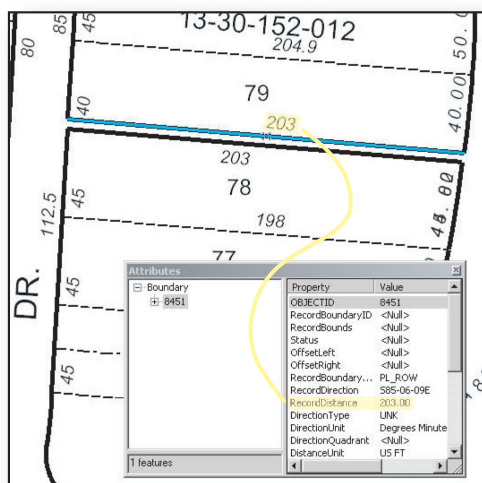
Note the Boundary subtypes. In ArcGIS, subtypes are useful for assigning symbology, default attribute values, relationship rules, connectivity rules, and topology rules. In the case of the Boundary feature class, the subtypes include Right of Way, Subdivision Boundary, Parcel, Lot Line, Parcel Split, Private Road, and Water. Parcel split and lot line might at first seem redundant, but these are created under different conditions. Lot lines are generally defined at the time a simultaneous conveyance is created and approved. However, over time, the original lot lines may not work as well for the owners as the original developer had intended.



For example, notice in this figure how the lot lines (gray dashed lines) fall between the parcel split lines (heavier dash-dot lines). The original platted lots have been combined and recombined over time, so the actual parcel splits now appear at a wider spacing than the lot lines.

All Boundary features have an attribute called RecordBoundaryStatus that may hold values of ambulatory, tidal, disputed, adjudicated, connecting line, computed, constructed, duplicate, archived, or unknown. Ambulatory boundaries are boundaries that move. Rivers and other riparian features define the most common ambulatory boundaries. Natural features can be linked to boundaries to define an ambulatory boundary and are shown in the boundary feature. Users can also modify or extend this list of RecordBoundaryStatus values according to their jurisdiction's practice and needs.

In some situations, boundary features may be left out of the model because they are redundant with other features, such as PLSS divisions or survey divisions. This is a matter of choice left to the user's discretion and local government policies.



Annotation, such as distance along a property line, can be linked to an attribute of a feature such as Boundary.

Simple feature class
Boundary

Geometry *Polyline*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length	
OBJECTID	OID							
Shape	Geometry	Yes						
RecordBoundaryID	String	Yes					30	The primary key for the line entity.
RecordBounds	String	Yes					30	Boundary location by call, related document, or known location.
RecordBoundaryStatus	String	Yes	Constructed	RecordBoundary-Status			30	Identifies the record boundary's status from a legal perspective.
OffsetLeft	Double	Yes			0	0		Distance left of and perpendicular to a defined boundary line.
OffsetRight	Double	Yes			0	0		Distance right of and perpendicular to a defined boundary line.
RecordBoundaryComment	String	Yes					100	Information about record boundary in the public record.
RecordDirection	String	Yes					30	Direction is angle between a line and an arbitrary reference line.
RecordDistance	String	Yes					30	The quantity for the linear-measure distance of a boundary.
DirectionType	String	Yes	Unknown	DirectionType			30	The basis of bearing or basis of azimuth for the direction.
DirectionUnit	String	Yes	DMS	DirectionUnit			30	Indicates the units for a direction.
DirectionQuadrant	String	Yes					10	Directions can be measured as either bearings or azimuth.
DistanceUnit	String	Yes	US Survey Feet	DistanceUnit			30	Defines units of measure and distance reference plane.
DistanceType	String	Yes	Unknown	DistanceType			30	Describes the reference surface for the distance.
Radius	String	Yes					8	Radius is distance from center of curve to any point on curve.
Delta	String	Yes					10	The central angle of a circular curve.
Tangent	String	Yes					8	Distance between point of tangency and intersection point.
ArcLength	String	Yes					8	The arc length is the long chord length.
Side	String	Yes					1	Side where radius point is located with respect to circular curve.
RBSourceAgent	String	Yes					30	Individual or organization determining record boundary values.
RBSourceIndex	String	Yes					30	Value assigned to record boundary document to identify source.
RBSourceType	String	Yes					30	Describes a family of documents, files, images, or other formats.
RBSourceDate	Date	Yes			0	0	8	The date of the record boundary document or other record.
RecordBoundaryType	Integer	Yes	1		0			Classification of boundary line to support definition of subtypes.
Shape_Length	Double	Yes			0	0		

A record boundary is the linear feature that represents the edge of a polygon feature, which may be a parcel or a parcel framework.

Subtypes of Boundary

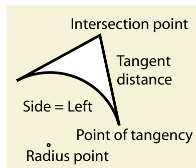
Subtype field *RecordBoundaryType*
Default subtype *1*

List of defined default values and domains for subtypes in this class

Subtype Code	Subtype Description
1	Right of Way
2	Subdivision Boundary
3	Parcel
4	Lot Line
5	Parcel Split
6	Private Road
7	Water

Field name	Default value	Domain
RecordBoundaryStatus	Constructed	RecordBoundaryStatus
DirectionType	Assumed	DirectionType
DirectionUnit	Unknown	DirectionUnit
DistanceUnit	US Survey Feet	DistanceUnit
DistanceType	Ground	DistanceType

These subtypes all share the same default values and domains.



Coded value domain
RecordBoundaryStatus

Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

Description
Ambulatory
Tidal
Disputed
Adjudicated
Connecting Line
Computed
Constructed
Duplicate
Archived
Unknown

Coded value domain
DistanceUnit

Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

Description
Chains
US Survey Feet
International Feet
Meters
Pole
Arpent
Perch
Rod
Stick
Vara
Vara - California
Vara - Texas
Unknown

Coded value domain
DirectionUnit

Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

Description
Decimal Degrees
Degrees Minutes Seconds
Radians
Gradians
Gons
Other
Unknown

Coded value domain
DirectionType

Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

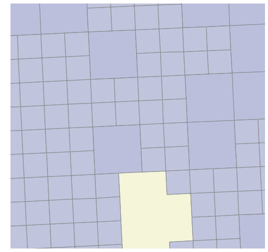
Description
Assumed
Astronomical North
Astronomical South
Geodetic North
Geodetic South
Magnetic North
Magnetic South
Unknown

Coded value domain
DistanceType

Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

Description
Ground
Sea Level
Grid
Unknown

Parcels may be tied to a system of known reference points for the greatest benefit within a GIS. Parcel frameworks provide a reference structure for locating parcels in space. A parcel framework is a set of polygon features in a nested hierarchy that enclose land parcels. For example, a simultaneous conveyance exterior boundary defines and contains the individual blocks and lots within the subdivision; a block further defines and contains a set of lots. This system of subdivisions, blocks, and lots constitutes a type of parcel framework.



Corners were presented first because they form the reference points on which boundaries and parcel frameworks are based. Parcel frameworks, in turn, provide the basis for describing collections of individual parcels.

PROPERTIES OF PARCEL FRAMEWORKS

There are many types of parcel systems that form hierarchical frameworks for describing landownership. The most widely used frameworks in the United States are simultaneous conveyances and the PLSS. Other parcel frameworks include offshore parcel frameworks, original government grants of land, ranchos, French claims, and Georgia military districts.

Parcel frameworks have the following characteristics.

• They are measured, often by survey. Parcel frameworks can be described and expressed in a GIS as they are tied to the measurements and placement of corners and boundaries.

• They form a hierarchical framework. This means that the parcel frameworks provide a structure that often includes the definition of senior boundaries, and these polygons provide a basis for describing land or describing ownership.

• They form closed polygons. This means that the exterior boundaries of this framework are intended to close.

The Oakland County data model instance includes two parcel frameworks: simultaneous conveyances and the PLSS. These may differ somewhat from the parcel framework in your jurisdiction, but they serve to illustrate what is needed in any parcel framework. Consider what is presented here as suggestive, not prescriptive, and adapt these parcel frameworks to your own policies and requirements.

SIMULTANEOUS CONVEYANCES

Simultaneous conveyances occur when several parcels are created at the same moment, such as lots in a subdivision, units in a condominium, or plots in a cemetery.

> *A simultaneously created boundary results when several parcels of land are created in the same legal instant by the same person, persons, or agency, and by the same instrument. All parcels have equal standard and no such portion can be said to have prior rights or seniority over any other portion. (Brown, 1995)*

Some texts describe PLSS townships as simultaneous conveyances, but they are modeled separately in the parcel data model because the PLSS hierarchical structure has special rules, as discussed below.

While state and local laws control the rules and definitions for simultaneous conveyances, there are some common features. For example, many simultaneous conveyances have a hierarchical structure, in which the exterior boundary is senior to interior lines. A typical pattern is that lots are nested within blocks, and blocks are nested within a simultaneous conveyance. However, the simultaneous conveyance may contain only lots and not blocks.

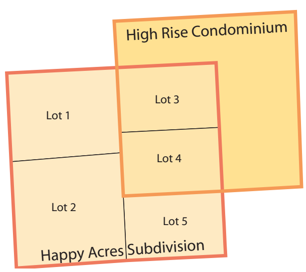
For the purposes of this parcel data model, the SimultaneousConveyance feature class is a polygon feature class for the external boundary of the conveyance, such as the subdivision exterior. The same feature class is also used to represent roads, blocks, or other polygon features which form subdivision-interior boundaries to the actual property parcels. The attribute ConveyanceType is used to specify which of several types of simultaneous conveyance applies to each feature.

One purpose of the SimultaneousConveyance feature class is to improve polygon rendering—for example, the external boundaries of plats may be shown with a heavier weight line or may be annotated differently.

Another purpose of the SimultaneousConveyance feature class is to provide a structure for parcel descriptions in subsequent feature classes. This feature class allows the parcel map to be related to underlying lots from which a parcel description is derived. Topology rules play an important role in parcel frameworks and will vary depending upon your specific needs.

Conceptually, simultaneous conveyances would be nonoverlapping, which means that at a point in time any piece of land that is in a simultaneous conveyance should be controlled or described by just one simultaneous conveyance. However, they may in fact overlap for several reasons. The two most common reasons are ambiguous legal descriptions and descriptions that are stacked over time. Therefore, the simultaneous conveyance features are potentially overlapping polygons that are noncontinuous; that is, simultaneous conveyances may not cover the entire jurisdiction, and they may appear to overlap.

In this map, the Happy Acres Subdivision plat shows five lots. Later, a condominium plat was developed that included lots 3 and 4 of the subdivision and other lands outside the subdivision. In this case, the High Rise Condominium overlaps the Happy Acres Subdivision. Many states would require that the portion of the subdivision included in the condominium be vacated, but other states allow this overlapping. Technically, the land that was in lots 3 and 4 would now be described as being in the condominium even though the legal description of the condominium itself includes a portion of the plat.



See the Federal Lands Data Model chapter for more examples of simultaneous conveyances.

Coded value domain
SimultaneousConveyanceType

Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

Code
Assessor Plat
Cemetery
Condominium
Farm Lot
French Long Lot
Indian Allotment
Plat of Survey
Protraction Block
Small Holding Claim
Small Tracts Act
Subdivision
Survey
Townsite
United States Survey
Other

Simple feature class
SimultaneousConveyance

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	OID						
Shape	Geometry	Yes					
ConveyanceID	String	Yes					64
ConveyanceDesignator	String	Yes					64
ConveyanceType	String	Yes	Subdivision	Simultaneous-ConveyanceType			30
Shape_Length	Double	Yes			0	0	
Shape_Area	Double	Yes			0	0	

A named or numbered area of land that can be identified by a type and a designator. These types of survey systems are created at one time in one document and all of the interior lines will have equal standing with one another.

This is a primary key for the polygon feature.
An identifying name or number for a specific type of conveyance.
Indicates the category or major class of the description.

DRAFT—ESRI

The SurveyFirstDivision and SurveySecondDivision feature classes support internal hierarchy within a simultaneous conveyance. The use of these classes depends on the nature of the simultaneous conveyance. For example, in the case where a simultaneous conveyance represents a subdivision of multiple blocks, the survey first division might be used to describe each block, and survey second division for individual lots. On the other hand, where a conveyance represented just a single block, the survey first division would represent the individual lots. Another way to look at this is that lots can be in blocks, or in subdivisions, or in simultaneous conveyances (e.g., government lots). Notice that both of these survey division feature classes have the ConveyanceType attribute, so it will be easy to tell each survey division feature's exact use.

This map shows a subdivision, in which the red line on the image is the external boundary. The first divisions are the blocks within the plat. The second divisions are the lots within the blocks. The first division polygons are not continuous because, as shown in this map, a road right-of-way separates the blocks. The second division polygons are the individual lots within the blocks. They are contained entirely within the block boundaries and are nonoverlapping and noncontinuous.

There is an important difference in the way some organizations manage conveyances from the example above. It is often the intent of subdivision platting statutes to provide a legal description of all lands contained within the subdivision. If this applies, then the more strict continuous polygon rule can be applied to the first and second divisions. It is also important to note that in some cases there are no blocks, that is, all the lots are numbered within the subdivisions. In this case the first division is the lot.

When creating SurveyFirstDivision features representing Right of Way, it may be tempting to create a single feature representing the boundary of an entire road network. However, it is generally considered good practice to break up such large polygon features at subdivision boundaries and other convenient breakpoints. This simplifies the topology maintenance and improves performance, especially in a versioned database.

Coded value domain
FirstDivisionType

Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

Code	Description
Block	Block
Lot	Lot
Tract	Tract
Right of Way	Right of Way
Unit	Unit
Fractional Part	Fractional Part
Claim	Claim
Parcel	Parcel
Plot	Plot
Survey	Survey
Other	Other

Simple feature class
SurveyFirstDivision

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	OID						
Shape	Geometry	Yes					
ConveyanceID	String	Yes					64
ConveyanceDesignator	String	Yes					64
ConveyanceType	String	Yes	Subdivision	Simultaneous-ConveyanceType			30
FirstDivisionID	String	Yes					100
FirstDivisionDesignator	String	Yes					100
FirstDivisionType	String	Yes	Block	FirstDivisionType			30
Shape_Length	Double	Yes			0	0	
Shape_Area	Double	Yes			0	0	

The primary division of the survey system, such as blocks and lots. These are nested within the simultaneous conveyance and do not cross its boundaries.

See SimultaneousConveyance
Name for the Conveyance, often a numeric value.
The type of conveyance.
The primary key for the polygon feature.
An alphanumeric designator used to identify the first division.
The classification of the first survey system division.

Second survey division polygons are shaded by type against an orthophoto background. This diagram shows blocks and lots within simultaneous conveyances.

Coded value domain
SecondDivisonType

Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

Code	Description
Fractional Part	Fractional Part
Outlot	Outlot
Lot	Lot
Tract	Tract
Parcel	Parcel
Other	Other

Simple feature class
SurveySecondDivision

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	OID						
Shape	Geometry	Yes					
ConveyanceID	String	Yes					64
ConveyanceDesignator	String	Yes					64
ConveyanceType	String	Yes	Subdivision	Simultaneous-ConveyanceType			30
FirstDivisionID	String	Yes					100
FirstDivisionDesignator	String	Yes					100
FirstDivisionType	String	Yes	Block	FirstDivisionType			30
SecondDivisionID	String	Yes					100
SecondDivisionDesignator	String	Yes					100
SecondDivisionType	String	Yes	Lot	SecondDivisonType			30
Shape_Length	Double	Yes			0	0	
Shape_Area	Double	Yes			0	0	

The second survey division is the subdivision of the first division. These are nested within the first division and do not cross the first division boundaries.

See SimultaneousConveyance

See SurveyFirstDivision

The primary key for the polygon feature.

Alphanumeric designator used to identify the first survey division.

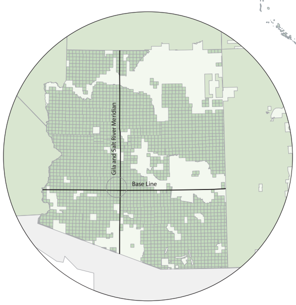
Describes the classification of the first survey system division.

Annotation feature class
SurveyFirstDivisionAnno

Geometry
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
FeatureID	Long integer	Yes			0		
ZOrder	Long integer	Yes			0		
AnnotationClassID	Long integer	Yes			0		
Element	Blob	Yes			0	0	0
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	

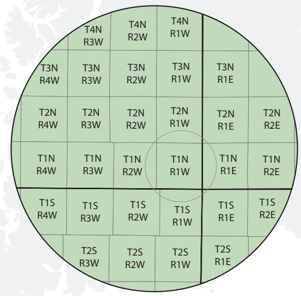
The PLSS is a set of baselines and principal meridians that define more or less equal divisions of land. It originated in the 1780's as a system for inventorying and selling the public domain, to help raise money for the new nation. Because it is the prevalent legal description framework in 32 of the United States, a set of PLSS feature classes is included in the parcel data model. The PLSS is implemented here as a hierarchical group of feature classes that define land descriptions.



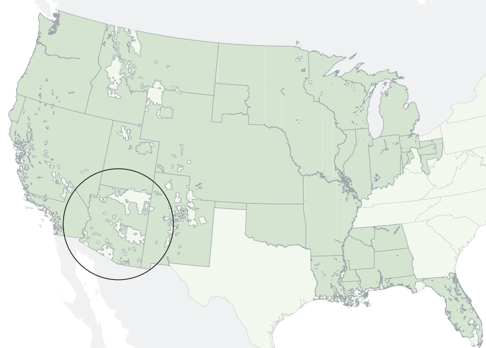
THE PUBLIC LAND SURVEY SYSTEM

In its idealized form, rectangular divisions begin with six-mile-by-six-mile townships that are numbered north and south of baselines, and east and west from principal meridians. To account for the convergence of meridians, east–west correction lines are established at regular intervals.

The huge task of surveying such a large area, quickly enough to accommodate the westward migration of population in the early 1800's, resulted in less-than-perfect township and section boundaries in many places. However, corrections were made in the size of sections and townships so that, on the whole, the system forms a consistent fabric.



Townships nominally are divided into 36 sections, each being nominally one mile by one mile. The townships can be divided into sections, tracts, lots and other types of divisions. If sections are the first division, these can be further divided into aliquot parts by quartering and lotting the sections. The PLSS nested feature classes are the polygon manifestations of the PLSS descriptions.



Townships as defined in the United States Public Land Survey System.

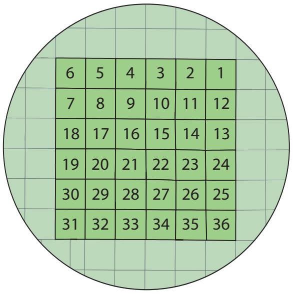
Simple feature class **PLSSTownship**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length	
OBJECTID	OID							
Shape	Geometry	Yes						
PLSSID	String	Yes					64	Primary key for the polygon feature.
PrincipalMeridian	String	Yes	NA	PrincipalMeridian			64	Reference for numbering of townships, ranges within a public land survey area.
TownshipDesignator	String	Yes					30	The number of rows of townships, north or south, from a PLSS origin.
TownshipDirection	String	Yes		TownshipTown-Direction			2	Direction of a row of townships from a Public Land Survey System origin.
TownshipFraction	Integer	Yes			0			Township fractions are created at gaps between surveyed township boundaries.
RangeDesignator	String	Yes					30	Indicates number of columns of townships, east or west from a PLSS origin.
RangeDirection	String	Yes		TownshipRange-Direction			1	Direction of a column of townships from a Public Land Survey System origin.
RangeFraction	Integer	Yes			0			Range fractions are created at gaps between surveyed township boundaries.
TownshipType	String	Yes	PLSS	Township Type			60	Indicates whether the township is surveyed, protracted or unsurveyed.
StateCode	Integer	Yes			0			Indicates the state in which the PLSS township is located.
Shape_Length	Double	Yes			0	0		
Shape_Area	Double	Yes			0	0		

SECTIONS IN A TOWNSHIP

This map illustrates the normal township section divisions with the sections numbered. However, there may be exceptions to this rule all across the public domain states. The township in this map is rectangular, but this is a generalization.



The nested components of the PLSS are described in the Cadastral Data Content Standard (FGDC, 1999).

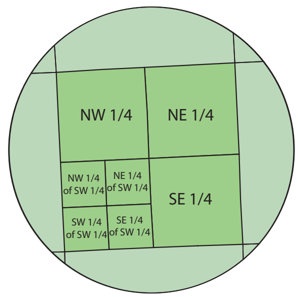
The PLSS township is the first or top level of polygon in the public land survey system. The principal meridian or baseline identifies PLSS townships. If the first division is not a PLSS township, then there is a survey name and potentially a secondary survey name. The survey name and secondary survey name generally occur in Ohio, the testing ground of the public land survey.

The first division of the PLSS township, as defined in the Cadastral Data Content Standard, is the division of the nominal six-mile-by-six-mile township areas. Townships are most commonly divided into sections, but can also be divided into tracts, protraction blocks, and other divisions.

The first divisions of the townships are nonoverlapping, and more than one type of first division can exist in a PLSS township.

The second division of the PLSS township, as defined in the Cadastral Data Content Standard, is a division of the first division. The most common second division divides a section into aliquot parts, which are formed by halving and quartering. However, second divisions can include government lots and tracts.

SUBDIVISIONS OF A SECTION



This map shows a section (640 acres) divided into quarter sections (160 acres) and one quarter section divided into sixteenth sections (40 acres).

The reason the quarter and sixteenth parts are included in the second division is that these are commonly occurring divisions and are nonoverlapping. Typically, all divisions of the section are defined once the center of section is established, even if they are not staked or described.

Simple feature class **PLSSFirstDivision**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	OID						
Shape	Geometry	Yes					
PLSSID	String	Yes					64
PrincipalMeridian	String	Yes					64
TownshipDesignator	String	Yes					30
TownshipDirection	String	Yes		TownshipTownDirection			2
TownshipFraction	Integer	Yes			0		
RangeDesignator	String	Yes		FirstDivisionSectionRange			30
RangeDirection	String	Yes		TownshipRangeDirection			1
RangeFraction	Integer	Yes			0		
TownshipType	String	Yes	PLSS	Township Type			60
StateCode	Integer	Yes			0		
FirstDivisionID	String	Yes					30
FirstDivisionDesignator	String	Yes					10
FirstDivisionSuffix	String	Yes					10
FirstDivisionType	String	Yes	Section	First Division Type			30
Shape_Length	Double	Yes			0	0	
Shape_Area	Double	Yes			0	0	

Public Land Survey System township first divisions are normally tracts or sections. This entity is the primary or first subdivisions of a township.

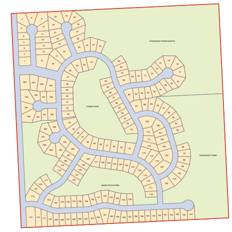
See PLSSTownship.

The numeric identifier of the first division.

The primary or first subdivision category. In most cases, a section.

DRAFT—ESRI

Tax parcels and tax rolls



The tax parcel is a polygon feature designed to support a real estate tax system. How these parcel polygons are managed varies by jurisdiction, as described earlier in this chapter. Regardless how they are defined, the parcel data model links tax parcel features with their associated tax roll records, which often are maintained in a separate database. The parcel model also makes special provisions for handling condominiums as tax parcels.

Simple feature class
TaxParcel

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	OID						
Shape	Geometry	Yes					
TaxPIN	String	Yes					30
TaxParcelType	String	Yes	Base Parcel	TaxParcelType			30
ExemptStatus	String	Yes	Non-Exempt	ExemptStatus			10
Shape_Length	Double	Yes			0	0	
Shape_Area	Double	Yes			0	0	

The tax parcel is a polygon defined for the purposes of supporting a real estate tax system. How these polygons are defined varies by jurisdiction.

Links to the tax roll, tax record, or assessment record.
An attribute for the tax parcel use classification.
Whether the tax parcel is subject to real property tax.

At the heart of a tax parcel record is the parcel identification number (PIN) assigned by the taxing authority. Several other tables refer to this number, which is called TaxPIN in this model.

Relationship class
TaxParcelHasCondos

Type *Simple*
Cardinality *One To Many*
Notification *None*
Forward label *CondoRelate*
Backward label *TaxParcel*

Origin feature class	Destination table
Name *TaxParcel* Primary key *TaxPIN* Foreign key *PrimaryTaxPIN*	Name *CondoRelate*

No relationship rules defined.

In many cases, a TaxParcel feature—sometimes called a base parcel—includes a number of condominium units. These might be part of a single building, as in the case of office space, or they may be separate buildings, as in the case of a planned community. The tax parcel may have a single address or multiple addresses. The base parcel and each condominium will have its own assessment and tax bill.

For tax roll analysis purposes, it may be important to find the base parcel associated with a given condominium parcel, and vice versa. For this reason, a TaxParcelHasCondos relationship class was created to associate each base parcel feature with its condominiums by TaxPIN. A separate CondoRelate table contains the TaxPINs of all condominiums, along with the associated base parcel's TaxPIN (held in the PrimaryTaxPIN field). Editing and inspection tools in ArcMap allow the user to directly browse this relationship for a given base parcel or condominium.

Relationship class
CondoHasTaxRoll

Type *Simple*
Cardinality *One To Many*
Notification *None*
Forward label *TaxRoll*
Backward label *CondoRelate*

Origin table	Destination table
Name *CondoRelate* Primary key *TaxPIN* Foreign key *TaxPIN*	Name *TaxRoll*

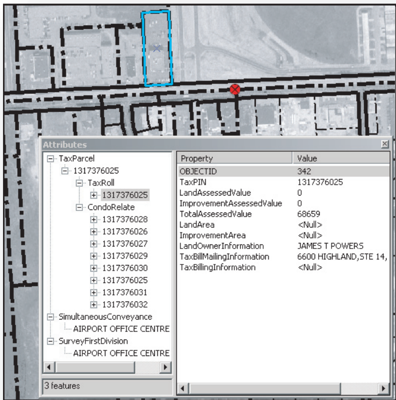
No relationship rules defined.

Relationship class
TaxParcelHasTaxRoll

Type *Simple*
Cardinality *One To Many*
Notification *None*
Forward label *TaxRoll*
Backward label *TaxParcel*

Origin feature class	Destination table
Name *TaxParcel* Primary key *TaxPIN* Foreign key *TaxPIN*	Name *TaxRoll*

No relationship rules defined.



Notice there is both a TaxParcel class and a TaxRoll class. The TaxParcel is a feature (geometric) class while the TaxRoll is an object (nonspatial) class. The TaxRoll class contains the detailed assessment and parcel owner contact information, while the TaxParcel class defines the location and geometry of the parcel, as well as its type. Tax parcel types include Base Parcel, Condominium, Right-of-Way Overlap, Unknown, and Other.

Tax parcels may also have some exemption from taxes. The exemption status codes in this model are Bankrupt, Exempt—whether for Local, County, State, Federal, Tribal, or any other jurisdiction, referred to as General here—Non-Exempt, Non-Profit, For Profit, Regulated, and Other.

Any given parcel feature may appear in multiple tax rolls, that is, for multiple tax years. In order to link parcel features with their corresponding tax roll records, a simple one-to-many relationship class called TaxParcelHasTaxRoll has been created.

Coded value domain
TaxParcelType
Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

Code	Description
Base Parcel	Base Parcel
Condominium	Condominium
ROW Overlap	ROW Overlap
Unknown	Unknown Ownership
Other	Other

Coded value domain
ExemptStatus
Field type *String*
Split policy *Default Value*
Merge policy *Default Value*

Code	Description
Bankrupt	Bankrupt
Exempt	Exempt - General
Local	Exempt - Local Govt
County	Exempt - County Govt
State	Exempt - State Govt
Federal	Exempt - Federal Govt
Tribal	Exempt - Tribal
Non-Exempt	Non-Exempt
Non-Profit	Non-Profit
For Profit	For Profit
Regulated	Regulated
Other	Other

Table
CondoRelate

Field name	Data type	Allow nulls	Length
OBJECTID	OID		
PrimaryTaxPIN	String	Yes	30
TaxPIN	String	Yes	30

This table contains the relationship between the tax parcel polygons and multiple tax records, such as those in a condominium. This table is used to connect the individual tax records for the units in the condominium to the larger polygon representation.

The linkage to the larger polygon, such as building polygon within which the multiple records are related.
The tax key number that links to information contained in the tax roll, the tax record, or the assessment record.

Table
TaxRoll

Field name	Data type	Allow nulls	Length
OBJECTID	OID		
TaxPIN	String	Yes	30
LandAssessedValue	String	Yes	30
ImprovementAssessedValue	String	Yes	30
TotalAssessedValue	String	Yes	30
LandArea	String	Yes	30
ImprovementArea	String	Yes	30
LandOwnerInformation	String	Yes	?
TaxBillMailingInformation	String	Yes	?
TaxBillingInformation	String	Yes	?

The tax roll is a listing of all property and its assessed value, but this object class is a generic listing for any related table that contains information that is linked to the tax parcels. This could include the property tax table, the assessment data, or a customized list of attributes used for mapping.

Tax key number that links to information contained in the tax roll, the tax record, or the assessment record.
Assessed value of the land.
Assessed value of any improvements.
Property value determined by the assessment authority and used to calculate a tax amount.
Land area for assessment purposes.
This is the size, in acres or square feet, to which the assessment is applied.
Name of the owner or taxpayer, included to support queries, information displays, and feature-based annotation.
Mailing address information, to be expanded for project needs.
This could include tax amounts, tax years, lottery credits, or payment information.

Further modeling of condominiums

Most jurisdictions have condominiums or other structures that can form common interest areas and three-dimensional surfaces with different owners on different levels of the structures. Such a structure may have multiple addresses, one for each tenant's unit. Jurisdictions differ in the amount of information they require for tax purposes, such as whether to capture every unit's geographic footprint in the tax parcel database. This section describes three alternative approaches for modeling condominiums that have been found to be most widely practiced.

It is useful to review a formal definition of condominiums to clarify the issues this parcel data model must address.

> *A condominium is a separate system of ownership of individual units in a multiple unit building; a single real property parcel with all the unit owners having a right in common to use the common elements with separate ownership confined to the individual units, which are serially designated. The condominium concept was not rooted in English common law and most condominiums in the US are formed in accordance with specific state enabling statutes. A condominium is an estate in real property consisting of an undivided interest in common in a portion of the parcel of real property together with separate interest in a space in a residential, industrial, or commercial building on such real property, such as an apartment, office, or store. (Black, 1991)*

In some jurisdictions, condominiums may look like a subdivision plat with the units laid out as if they were lots and the common elements looking like rights-of-way as shown in the left side of the image below. Other condominiums are stacked (sometimes called vertical) parcels that come into play when the condominium is a single large building, as shown in the right side of the below image.

There are two special cases with condominiums: *common elements* and *unit ownership*.

COMMON ELEMENTS

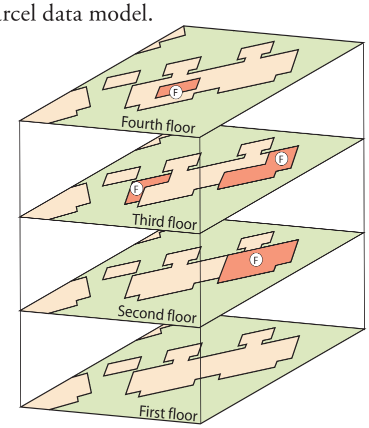
In many jurisdictions, values and assessments of the common elements are prorated across the individual ownership parcels in the condominium, but common elements may also be mapped, assessed, and managed separately. Common elements may be assigned to the condominium owners as a group, the condominium association, or the developer. The assessment on common elements may be assigned to the individual units or the common elements may be exempt from assessment and taxes.

The decision of whether to create a separate ownership polygon for the common elements or manage the condominium as a single polygon depends on the assessment system, and on the level of detail and parcel maintenance the jurisdiction wants to employ.

UNIT OWNERSHIP

The units or buildings in the condominium are part of the ownership parcels with a vertical aspect and are called vertical parcels in the parcel data model.

This illustration shows a vertical parcel that is a condominium building with condominium unit F on three separate floors. Unit F is connected by common elements, such as stairways and elevators.

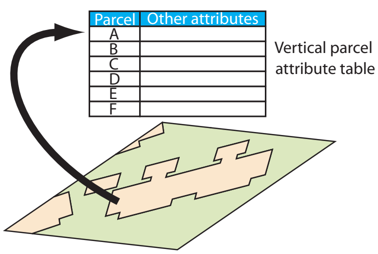


The common elements appear as holes or gaps through the elements of parcel F. The common elements provide access to parcels in the vertical condominium similar to how a right-of-way provides access to more traditional flat parcels.

In the parcel data model there are several ways to model or represent vertical parcels:

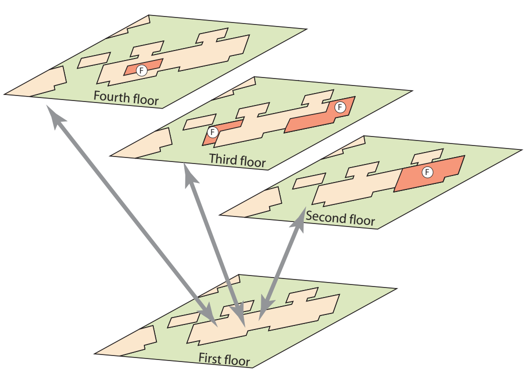
- A single base polygon pointing to multiple parcel records
- A single base polygon pointing to another series of polygons that represent the levels or floor
- A single base polygon that points to a three-dimensional model of the building

A single base polygon pointing to a series of parcel records has one graphic of the condominium. In this approach, the information about multiple owners is stored in attribute tables, but there is not an accompanying graphic that outlines the footprints or polygons of the separate owners in the condominium.



An image of the condominium plat could also be attached to the base polygon.

The second approach is to have the base polygon as part of the ownership object that points to or is related to another series of polygon objects. Each related polygon represents a layer or floor of the condominium with the individual owners and common elements indicated.



There are three polygons related to the base polygon; each of these is a level or floor. The area owned by owner F is indicated in each level polygon. An accompanying table could summarize all of the holdings of owner F. Conversely, a table could be associated with each level that describes the owner or owners on that floor.

The third approach is to have a three-dimensional model of the building. This is a more complex approach. However, like the first two approaches, the three-dimensional model would be related to the parcels through the condominium outline polygon. In the parcel polygons, the exterior of the condominium is shown on the parcel map with a polygon type indicating that it is a vertical parcel.

A land parcel has many meanings across different organizations, disciplines, and situations, which go beyond its use for property tax administration. In a GIS, parcels are simply represented as polygons. Their data models become more complex in order to tie parcels to cadastral frameworks, to manage ownership rights, interests, and restrictions, and for taxation. Various international conventions further complicate the picture, depending on the nationality of interest.

From a parcel mapping perspective, local governments in the United States frequently use property tax parcels as the basis for parcel management. Other organizations begin parcel mapping with an ownership parcel defined by the official Register of Deeds records. Still others use zoning, land use, mineral rights, or farmland conservation as the basis for parcel mapping.

The simplest and broadest definition used in the United States for a parcel is:

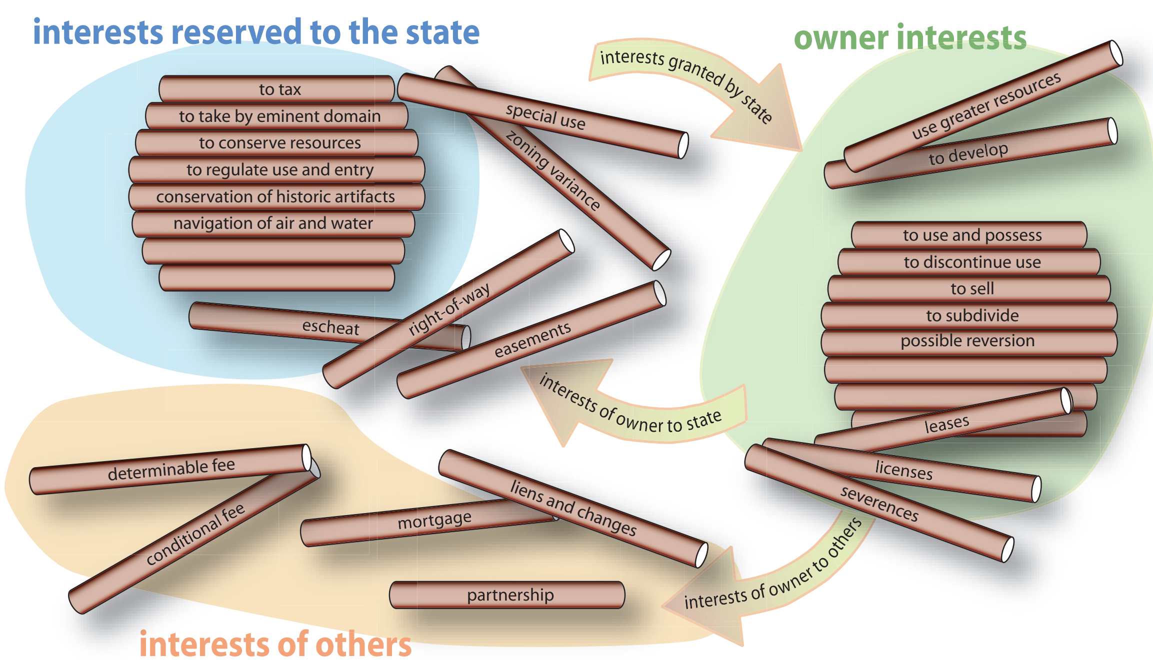
> *A parcel is a unit of real property with rights and interests. (Moyer and Fisher, 1973)*

The FGDC expanded this definition slightly:

> *A parcel is a single cadastral unit, which is the spatial extent of the past, present, and future rights and interests in real property. (FGDC, 1999)*

Both of these definitions portray the parcel as a set of rights and interests. This is because landownership parcels are not as simple as they may appear at first glance.

> *Although we speak of "owning" land, land in fact cannot be owned. It is the rights to use the land that are owned or held. Over time, rights and interests in land have passed from groups, or society, to individuals. These rights are conceptualized as a "bundle of sticks". (Danielsen,1993).*



The sets of rights and interests individuals, organizations, or agencies hold define the uses that owner can enjoy.

> *The collection of rights pertaining to any one land parcel may be likened to a bundle of sticks. From time to time the sticks may vary in number (representing the number of rights), in thickness (representing the size or 'quantum' of each right), and in length (representing the duration of each right). Sometimes the whole bundle may be held by one person or it may be held by a group of persons such as a company or a family or clan or tribe, but very often separate sticks are held by different persons. Sticks out of the bundle can be acquired in different ways and held for different periods, but the ownership of the land is not itself one of the sticks; it must be regarded as a vessel or container for the bundle, the owner being the person (individual or corporate) who has the right to give out the sticks... (Simpson, 1976)*

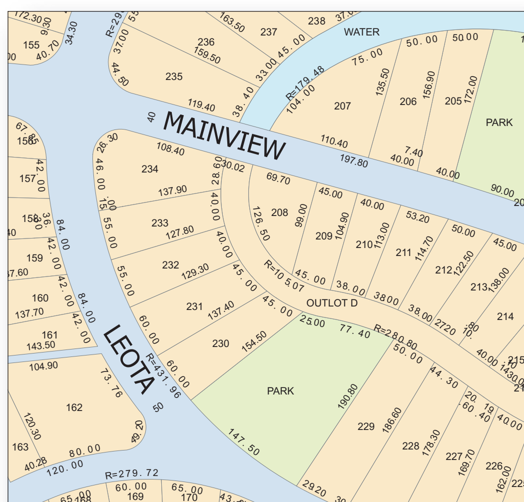
This view of landownership in the U.S. is the result of centuries of evolving practices. In general, countries influenced by Roman law or the Napoleonic Code view land as a commodity which can be owned in whole, while countries influenced by the British common law regard land as something to which one can have rights, that is, potentially, multiple independent owners. Most land tenure systems in Asia have been strongly influenced by the concepts of the British common law. All countries, regardless of their tenure system, have restrictions on land use in the interests of society. *(Williamson and Ting, 1999)*

Since feudal times in Europe when cadastre was mainly used to publicly record ownership and support fiscal accounting, it has grown to support land transfer and land markets in the Industrial Age, and urban and regional planning in the post-World War II era. Since the 1980's:

> *The focus has turned to wider issues of environmental degradation and sustainable development, as well as social equity. All of these issues will likely temper short-term economic imperatives. Planning issues have widened to include more community interests and deepened to address more detailed issues of land use. This has created a growing need for more complex information about land and land use, and the desire for multipurpose cadastres. (Ting and Williamson, 1999)*

It is not practical in this chapter to show examples of the parcel data model that would completely illustrate its use in every county and country. The examples in this chapter are largely drawn from Oakland County, Michigan, which does not map ownership parcels, but references ownership information via the Register of Deeds office. However, the essential data model showing all the feature classes which have been developed through data model consortium activities is presented here, including ownership feature classes for completeness.

The ownership parcels in the parcel data model represent the surface ownership parcels. The specific set of rights and interest held in the surface are described in feature attributes and related objects. The mineral estate or subsurface ownership and overhead air rights are described in the separated rights. Easements across the land are represented in encumbrances. These are all described and illustrated in the sections to follow.



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Ownership parcels

Most local governments in the U.S. do not manage both tax parcels and ownership parcels. Ownership parcels would be of use where the Register of Deeds was tightly integrated with the parcel mapping function. In the U.S., ownership parcels are normally of more interest in the context of federal lands management, such as to control mineral rights, grazing rights, and so on. However, there are a few local governments that manage ownership parcels instead of tax parcels, and even some that manage both. The model described here contains the building blocks for any agency's use of

Oakland County does not manage ownership parcels because taxation is their primary focus. For those agencies that are more concerned with ownership, the next set of feature classes illustrate a general approach for ownership modeling.

Three polygon feature classes define ownership parcels in this parcel data model: OwnerParcel, SeparatedRights, and Encumbrance. These are basic parcel building blocks and can be used to support the many varied definitions of land parcels. The ownership parcels in the parcel data model represent *surface* ownership parcels. The specific set of rights and interest held in the surface are described in feature attributes and related objects. The mineral estate or subsurface ownership and overhead air rights are described in the separated rights. Easements across the land are represented in encumbrances.

OwnerParcel features are characterized as:

• Continuous—All land has ownership. The exact name of the owner may not be known. The exact spatial extent of ownership may not be known, but all land area has continuous ownership. There may be conflicts in ownership, but this does not negate that the ownership is intended to be continuous.

• Nonoverlapping—All land has a single set of current owners. If the surface ownership appears to be in conflict, this may be due to an error in a legal description or to some other ownership conflict or uncertainty.

Conflicts in ownership results (a) where two parties are given title to the same land or (b) where one party has title and another has possession or (c) where descriptions are ambiguous. (Brown, 1969)

Notice the subtypes of OwnerParcel shown in the table on the next page. These are chosen to support many common queries, as well as for proper symbolization. No particular attribute values are shown for these subtypes, as these would be dependent on each jurisdiction's policies and practices.

Each OwnerParcel is linked to its owner record through the parcel ID. This choice of key field, rather than owner ID, is preferred because parcel IDs are easier to control and maintain. The OwnerParcel also has an attribute for OwnerClassification (e.g., local, state, federal government, or private sector), to support common queries and reporting requirements.

The VerticalParcel table shown here is slightly different than the VerticalParcel table shown previously, to illustrate the kind of adaptation users might make to the template. Vertical ownership parcels are similar to the CondoRelate illustration given for tax parcels. This example uses BuildingID and UnitID attributes to identify an ownership parcel, rather than Sequence number as shown above. The best choice of vertical parcel attributes depends on the purpose for the data and the level of detail available in the source data.

In the class descriptions shown so far, there are no implied relationships between owner parcels and tax parcels. However, in a jurisdiction that did maintain both, there is no reason these feature classes couldn't share the same topology, with rules such as "TaxParcel must be covered by OwnerParcel."

See also the chapters on Federal Lands Data Model and the Urban Data Model for more examples and discussion of ownership parcels.

Simple feature class **OwnerParcel**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

An owner parcel represents a unit of real property on the surface with rights and interests.

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length	
OBJECTID	Object ID							
Shape	Geometry	Yes						
ParcelID	String	Yes					30	The primary key.
ParcelLocalLabel	String	Yes					64	A cartographic name for the parcel.
ParcelName	String	Yes					64	The common name for the parcel.
OwnerClassification	String	Yes		OwnershipClassification			64	Categories of public, private, and trust.
ManagingAgency	String	Yes					64	Government agency managing this parcel if owner is public or trust.
Area	Double	Yes			0	0		The legal area of the parcel.
AreaType	String	Yes	Lot				20	Units used for the legal area.
Shape_Length	Double	Yes			0	0		
Shape_Area	Double	Yes			0	0		
ParcelType	Long integer	Yes	1		0			The cartographic classification of parcels.

Subtypes of OwnerParcel

Subtype field *ParcelType*
Default subtype *1*

List of defined default values and domains for subtypes in this class

Subtype Code	Subtype Description	Field name	Default value	Domain
1	Park	No values set		
2	Lake	No values set		
3	Forest	No values set		
7	Other	No values set		
4	Other water	No values set		
5	Recreation area	No values set		
6	Recreation trail	No values set		
8	Private lands	No values set		
9	Right-of-way	No values set		

Relationship class **OwnerParcelHasOwner**

Type *Simple*
Cardinality *Many to many*
Notification *None*
Forward label *Owner*
Backward label *OwnerParcel*

Origin feature class	Destination table
Name *OwnerParcel*	Name *Owner*
Primary key *ParcelID*	Primary key *OwnerID*
Foreign key *ParcelID*	Foreign key *OwnerID*

No relationship rules defined.

Table **Owner**

Represents the owner and interests.

Field name	Data type	Allow nulls	Precision	Scale	Length	
OBJECTID	Object ID					
OwnerID	String	Yes			60	The primary key.
OwnerName	String	Yes			60	Person or corporation with interest.
PercentOwned	Long integer	Yes	0			The fraction of ownership.
OwnershipRole	String	Yes			30	The type of interest owner has in the parcel.

Relationship class **OwnerParcelHasVerticalParcel**

Type *Simple*
Cardinality *One to many*
Notification *None*
Forward label *VerticalParcel*
Backward label *OwnerParcel*

Origin feature class	Destination table
Name *OwnerParcel*	Name *VerticalParcel*
Primary key *ParcelID*	
Foreign key *PrimaryParcelID*	

No relationship rules defined.

Table **VerticalParcel**

A vertical parcel represents buildings or units in a condominium.

Field name	Data type	Allow nulls	Precision	Scale	Length	
OBJECTID	Object ID					
ParcelID	String	Yes			30	The primary key.
PrimaryParcelID	String	Yes			30	The foreign key to OwnerParcel.
Area	Double	Yes	0	0		The legal area of the parcel.
UnitID	String	Yes			20	The unit designation.
BuildingID	String	Yes			8	The building identifier.

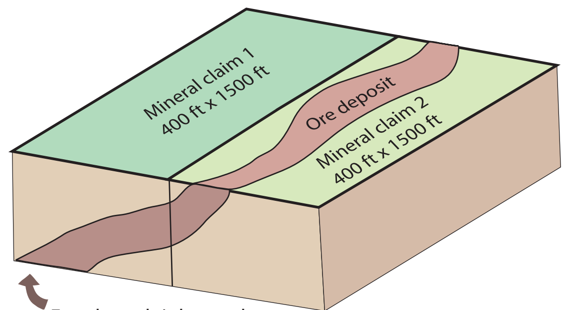
Separated rights are rights and interests in landownership that have been disconnected from the primary or fee simple surface ownership. For example, mineral and oil rights are often separated from the surface ownership. Above-ground air rights may be separated as well. Some countries do not recognize this notion, having the custom of recognizing ownership of land "to the center of the earth." For those countries in which certain rights can be separated, these rights are represented in the parcel data model as polygon features.

SEPARATED RIGHTS

Separated rights are represented as overlapping noncontinuous polygons. The separated rights are modeled similarly to encumbrances (see below). Some of the idiosyncrasies of separated rights are:

- There are often future estates and leases associated with minerals. In these cases the mineral rights may be separated from the surface for a limited period of time.
- The mineral rights can be divided according to the mineral. For example, fossil fuels, oil and gas, sulfite minerals, and surface quarry rock are often considered as distinct separated rights.
- The apex rule for minerals that are found as defined veins and are claimed under the 1872 mining claims act provides for extralateral rights. This means that whoever claims the surface expression of a veined mineral deposit has the rights to the mineral deposit even though it may pass under the land of adjoiners. This is shown below.

There are also above-ground separated rights. The above-ground separated rights include things such as solar easements and transferable development rights (TDRs). These, too, are potentially overlapping and noncontinuous polygons. Overhead or above-ground separated rights tend to be three-dimensional envelopes, although they can be expressed with a flat or two-dimensional expression.



Separated rights are modeled as polygon features. There could be any number of overlapping polygons based on the type of mineral. Examples of mineral claim types include lode, which is a mineral that is in place and generally in a vein, or placer, which is all forms of mineral deposits that are not in place and are generally minerals in a loose state. The model includes a ParcelReference table for storing additional details about specific separated rights.

Simple feature class
SeparatedRight

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Precision	Scale	Length	
OBJECTID	Object ID					
Shape	Geometry	Yes				
SeparatedRightID	String	Yes			30	The primary key.
RightOwner	String	Yes			30	Owner of the right.
RightType	String	Yes			30	Type of right.
RightMineral1	String	Yes			30	
Area	Double	Yes	0	0		The legal area of the separated right.
AreaType	String	Yes			30	Unit used for the legal area.
Shape_Length	Double	Yes	0	0		
Shape_Area	Double	Yes	0	0		

A separated right represents rights and interests in landownership that can be disconnected from the primary surface ownership.

Attributed relationship class
RightsHaveReferences

Type *Simple*
Cardinality *Many to many*
Notification *None*

Forward label *ParcelReference*
Backward label *SeparatedRight*

Origin feature class	Destination table
Name *SeparatedRight*	Name *ParcelReference*
Primary key *SeparatedRightID*	Primary key *DocumentNumber*
Foreign key *SeparatedRightID*	Foreign key *DocumentNumber*

No relationship rules defined.

Field name	Data type	Allow nulls	Precision	Scale	Length
SeparatedRightID	String	Yes			60
DocumentNumber	String	Yes			60
RID	Object ID				

Table
ParcelReference

Field name	Data type	Allow nulls	Precision	Scale	Length	
OBJECTID	Object ID					
SourceID	String	Yes			60	The primary key.
DocumentNumber	String	Yes			60	Common reference for document.
VolumePage	String	Yes			30	Page number in the volume.
DocumentType	String	Yes			10	Which ownership rights are held.
DocumentDate	Date	Yes	0	0	8	Date of the document.
EffectiveDate	Date	Yes	0	0	8	Date of approval or recording.
ExpirationDate	Date	Yes	0	0	8	Date the document expires.

A parcel reference contains additional information about the parcel.

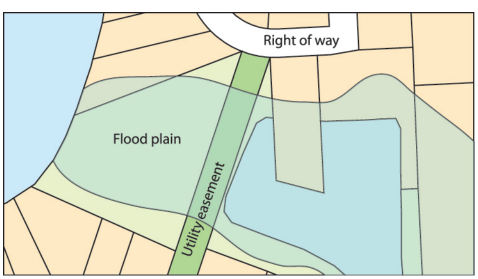
Encumbrances are limitations on the use of land. Rights-of-way and utility easements are two common types of encumbrance, but there are many others, such as the U.S. Corps of Engineers' right to flood an area when creating a lake. Encumbrances are polygon features that may cover part or all of a parcel or group of parcels, and may have an associated legal description. Mortgages and liens are types of encumbrances that can be described using the ParcelReference table. Still more elaborate systems can be developed based on your specific needs.

ENCUMBRANCES

> *Any right to, or interest in, land which may subsist the fee [ownership] by another to the diminution of its value, but consistent with the passing of the fee [ownership] by conveyance. A claim, lien, charge, or liability attached to and binding real property; examples are a mortgage, judgment lien, mechanics' lien, lease, security interest, easement, or right of way. If the liability relates to a particular asset, the asset is encumbered. (Black, 1991)*

Most encumbrances run with the land. That is, they are tied to the land and will persist from owner to owner. Others exist at the pleasure of the owner. Encumbrances may have an effective date and expiration date. In the parcel data model, encumbrances are polygon features having their own legal description. Encumbrances are characterized as:

- Overlapping—Encumbrances can overlap. For example, ingress/egress of an easement or a prescriptive right-of-way can all overlap.
- Noncontinuous—There are many areas of land that are free from encumbrances.

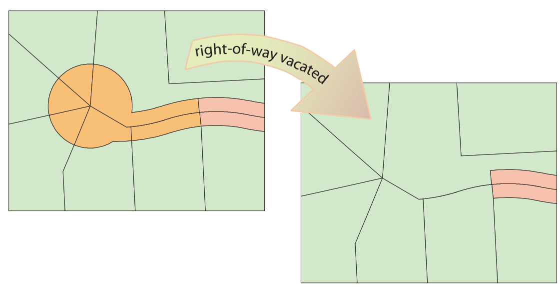


This map shows a parcel with a utility easement and a prescriptive road right-of-way. The encumbrances overlap and are noncontinuous as described above.

The question of whether roads are an encumbrance or a fee simple interest varies from jurisdiction to jurisdiction. Brown (1995) defines a prescriptive easement as:

> *...the acquisition of an easement by adverse use under claim of right for a statutory period required by law.*

In many states prescriptive easements are a specified width such as 4 rods (66 feet). The description of an ownership parcel may extend to the center of the prescriptive right-of-way, but the public controls the use of land in the prescriptive easement. This is a case where one of the sticks in the bundle of rights for the parcel belongs to the public for a right-of-way. The owner may have future reversion rights if the right-of-way is vacated (abandoned).



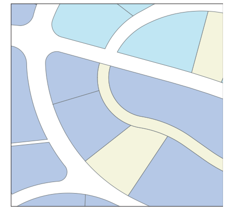
These before and after maps show one example from a parcel map where an encumbrance was vacated and adjoining parcels took reversion rights for their portions of the vacated right-of-way.

Should prescriptive areas be shown as publicly held parcels in the ownership parcels or should the underlying owner be shown with the prescriptive right or reversion right shown as an easement? The parcel data model allows for either scenario and it would be up to each jurisdiction to decide how they would map and manage prescriptive easements and reversion rights. If the prescriptive areas are separate ownership, then the ownership representation is continuous. If the underlying landowner is shown as holding the land with an easement on top, the ownership is still represented as continuous polygon features with encumbrances to represent the full picture. The differences will be in the processes applied to determine the tax parcel and in how related tables and relationships are connected to the objects.

Encumbrances are limitations on rights and uses of land.

Simple feature class **Encumbrance**		Geometry *Polygon* Contains M values *No* Contains Z values *No*				
Field name	**Data type**	**Allow nulls**	**Precision**	**Scale**	**Length**	
OBJECTID	Object ID					
Shape	Geometry	Yes				
EncumbranceID	String	Yes			30	The primary key.
EncumbranceType	String	Yes			30	Types, such as easement, claim, lien, and right-of-way.
EncumbranceOwner	String	Yes			64	Name of the owner.
Area	Double	Yes	0	0		The legal area of the parcel.
AreaType	String	Yes			20	The units used for the legal area.
Shape_Length	Double	Yes	0	0		
Shape_Area	Double	Yes	0	0		

There are essential feature classes for parcel users that are slightly beyond the scope of a parcel data model. These are called Related Uses because they are closely related to parcels but are not likely to be managed by a parcel mapping group. Addresses are typically assigned by a city's legal addressing authority. Regulated Uses and Restrictions are outputs from the community planning process.



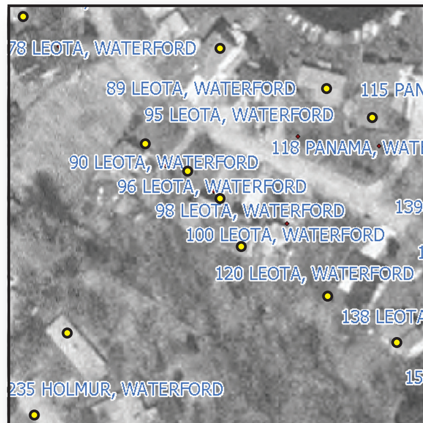
The feature classes in this section are examples to illustrate the connection between the parcel data model and these uses. For general purposes of the parcel data model, these feature classes are grouped with other Administrative feature classes, in a feature class collection that is independent of parcel topology. Users may also wish to create more expansive data models for site addressing, regulated uses, and restrictions.

SITE ADDRESSES

Maps and representation of parcel information through an address point can serve many departments. Site addresses are points that are within a parcel and serve as a location for the site address information.

Site address *points* are a geolocation for a site address. Most site addresses are assigned to structures. For example, a building may have one site address that can span multiple parcels; a parcel may not have a site address, such as vacant land; or a parcel could have multiple site addresses, such as parcel with many buildings or businesses.

For some applications there may also be important supplemental address points. For example, in rural environments there may be related points that identify the end of the driveway for emergency vehicles. In urban environments there may be points that identify entrances to and turns on major roads to gain access to the parcel. These related points are not included in this parcel data model design but it is recognized that these can be important points.



This map illustrates structures on parcels with site address points. Parcel information can be linked to the site address point. The structures may have more than one address, as in the condominiums.

Simple feature class SiteAddress — Geometry *Point*; Contains M values *No*; Contains Z values *No*

Represents important addresses and their locations within a parcel. Can be used for simple parcel mapping or more sophisticated address management purposes.

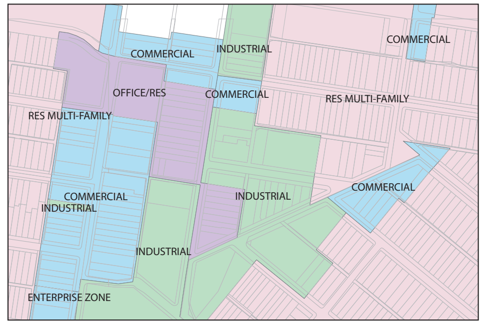
Field name	Data type	Allow nulls	Length	Description
OBJECTID	OID			
Shape	Geometry	Yes		
AddressText	String	Yes	64	The street number and all prefixes and suffixes including the full street name.
StreetNumber	String	Yes	10	Number assigned to building or land parcel along the street to identify location and to ensure accurate mail delivery.
StreetNumberSuffix	String	Yes	10	A subnumber to a street number.
StreetPrefix	String	Yes	10	A predirectional field.
StreetName	String	Yes	64	Official name of a street is assigned by a local governing authority.
StreetType	String	Yes	10	Generally defined by the postal service and includes common street indications such as street, avenue, boulevard.
StreetSuffix	String	Yes	10	The directional symbol that represents the sector of a city where a street address is located.
Municipality	String	Yes	64	A finer partitioning of geographic subdivisions of a county, usually associated with additional levels of government.

REGULATED USES

Regulated uses represent limitations imposed on land by a public agency. These are independent of the chain of title. One common example is land use zoning.

The map to the right illustrates Euclidean Zoning, a type of zoning based on district and use.

The information on the restrictions on the nature, usage, and physical dimensions, including setbacks and density for these districts, would be described in a Zoning Ordinance.



Simple feature class **RegulatedUse**

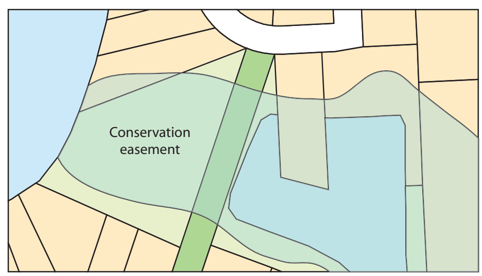
Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Precision	Scale	Length
OBJECTID	OID				
Shape	Geometry	Yes			
RegulatedID	String	Yes			30
RegulationType	String	Yes			8
RegulationClassification	String	Yes			30
RegulationDescription	String	Yes			64
RegulationAgency	String	Yes			64
Shape_Length	Double	Yes	0	0	
Shape_Area	Double	Yes	0	0	

Regulated use polygons capture information related to limitations or permissions for the use and enjoyment of land by a public agency or public authority. Zoning is a common example of a regulated use.

The primary key for object class.
Indicates the category, source, or location of the regulation such as a zoning district.
The district or classification of the regulation applied by the public agency.
Describes the regulations that are applied to the polygon such as setbacks.
The public agency that enforces the regulated use.

In the map to the right, the zoning district boundaries are contiguous with the parcel boundaries, but this may not always be the case.



RESTRICTIONS

Restriction polygons capture information related to limitations or permissions for the use and enjoyment of land by the land right holder, such as a homeowners' association that prohibits members from parking recreational vehicles in the driveway, or from having detached garages.

Simple feature class **Restriction**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	OID						
Shape	Geometry	Yes					
RestrictionID	String	Yes					30
RestrictionType	String	Yes	Restrictive-Covenant	Restriction-Type			20
RestrictionDescription	String	Yes					30
RestrictionAgency	String	Yes					64
Shape_Length	Double	Yes			0	0	
Shape_Area	Double	Yes			0	0	

Restriction polygons capture information related to limitations or permissions for the use and enjoyment of land by the land right holder.

The primary key for object class.
Indicates the category, source, or location of the restriction.
Describes the restriction on the parcel.
Person, individual, or organization to whom the restriction applies.

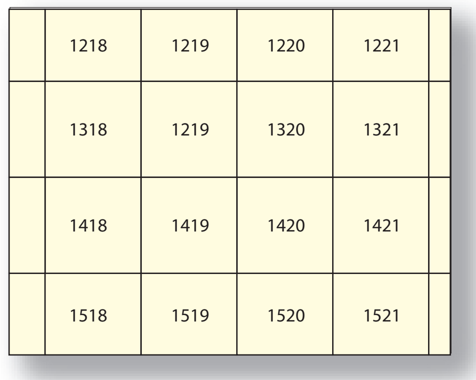
ADMINISTRATIVE AREAS

Administrative areas are a generic term for many different kinds of overlays that may or may not coincide with parcel boundaries. Two kinds of boundaries are discussed here: map index and tax district. In practice, GIS users of this data model will create any number of additional administrative areas depending on their application needs.

Administrative areas are any division of land for managing or governing programs or agencies. Very common examples include map indexes, school and tax districts, and service areas—water service, pumping stations, trash collection areas, and so on.

MAP INDEX

A common type of administrative area is a Map Index, used in conjunction with a local government's series of mapsheets of its jurisdiction. These are usually square areas defined at regular intervals, such as 1/8, 1/4, or 1/2 mile, or they may be based on a coordinate system, such as a state plane coordinate system, and be defined by a constant east and north coordinate value. From the map index, a user can find where the hardcopy or online map for that area is stored.



Simple feature class **MapIndex** — Geometry *Polygon*; Contains M values *No*; Contains Z values *No*

Field name	Data type	Allow nulls	Prec-ision	Scale	Length
OBJECTID	OID				
Shape	Geometry	Yes			
MapSheetNumber	String	Yes			60
Shape_Length	Double	Yes	0	0	
Shape_Area	Double	Yes	0	0	

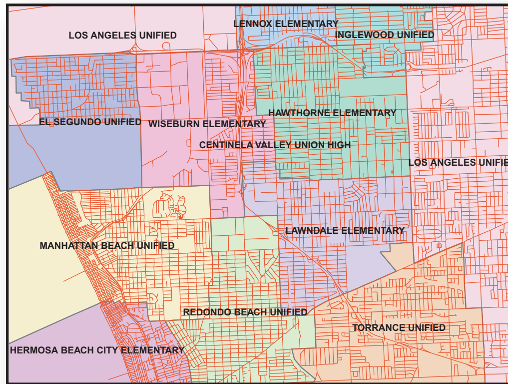
These are usually square areas defined at regular intervals, such as every mile or they may be based on a coordinate system, such as a state plane coordinate system, and be defined by a constant east and north coordinate value.

The label or other identifier of the cell within a map index system.

TAX DISTRICT

In the figure to the right, the boundaries define what schools children attend and which school taxes are levied on the property tax roll. Notice that the school district boundaries do not always follow the owner parcel boundaries, but generally do follow tax parcel boundaries. The other administrative areas shown are neighborhoods, which generally follow owner parcel boundaries, although there are exceptions.

School districts are a kind of tax district. Counties, cities, villages, towns, and townships are other examples of administrative areas. These types of areas may benefit from parcel information as a reference or they may be intended to follow parcel boundaries.

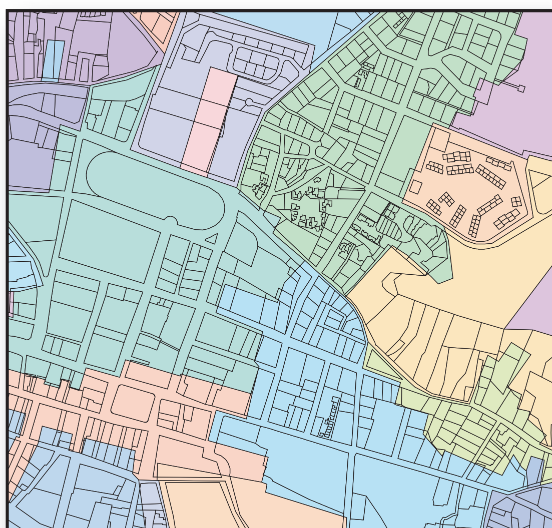


Simple feature class **TaxDistrict**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

Field name	Data type	Allow nulls	Precision	Scale	Length	
OBJECTID	OID					
Shape	Geometry	Yes				
AreaName	String	Yes			60	The Type of tax district.
ParentName	String	Yes			60	The name of a parent tax district.
DistrictName	String	Yes			60	The name of the tax district.
DistrictCode	String	Yes			60	The common code used for the district.
Shape_Length	Double	Yes	0	0		
Shape_Area	Double	Yes	0	0		

Defined Tax Districts based on areas of similar value and characteristics for taxation purposes.

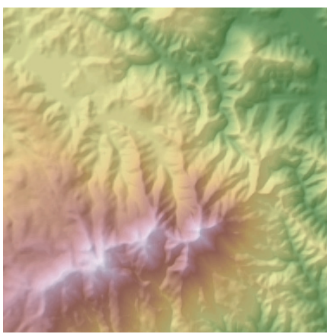


DRAFT—ESRI

Three data layers are commonly used as a base reference for parcels: orthophotos, elevation, and a comprehensive representation of surveys for the study area. Orthophotos are useful for providing up-to-date, spatially referenced imagery to help locate structures in and around parcels, such as buildings and roads. Digital elevation datasets provide a relief map for a study area. Survey datasets provide a highly accurate control network to tie parcels to ground locations.

RASTER DATASETS

For decades, many local governments have collected aerial photographic records of their jurisdictions. Today, it is possible to obtain less-expensive satellite imagery with sufficient resolution to replace photogrammetry in many applications. In most areas, especially metropolitan, these have to be updated on a regular basis to be of use. Given enough time, the historical library of these records can also become very interesting for research and analysis.



In addition to aerial photographs and satellite imagery, another form of raster data is a grid of elevation postings. A coarse grid (30m) for the U.S. called the National Elevation Dataset (NED) has been compiled and is available from the U.S. Geological Survey (USGS). Additional raster datasets can be derived from an elevation grid, such as hill-shaded grids and watershed drainage grids. For example, the complete 30m hill-shaded digital elevation model (DEM) for the U.S. is available online from the USGS through the Geography Network[SM] (*www.geographynetwork.com*) and can be freely added as a layer in a map document without downloading the data to a local server.

Whatever the application, a local government can acquire numerous raster datasets. These can be stored in the same or different geodatabases from the other parcel-related data. Depending on users' requirements for access, use, and update of this data, it may be organized in a number of different ways. For example, suppose a county government has 1,000 aerial photo images covering the county. One approach is for each raster image to be stored as a separate record in a single table. Another way is for all the raster images to be mosaicked together. Still another way is for the raster images to be kept outside the geodatabase as GeoTIFF, JPEG, or other image format files, and linked to users' map documents, as needed. Each approach has its pros and cons, depending on the application, network configuration, system loading, and other considerations.

The chapter on the Raster Data Model provides more examples and discussion of raster datasets.

Detail of orthophoto base from Oakland County, Michigan

SURVEY DATASETS

Surveying is the science of collecting measurements to determine the relative spatial locations of points on or near the surface of the earth. Named spatial locations are represented by one or more coordinate points.

To establish coordinates for points, surveyors use precise field instruments, procedures, and computations. They measure slope, horizontal, and vertical distances between points, and angles between lines of sight. Each subsequent survey updates point locations and adds to a computation network.

Measurments, computations, survey points, and coordinates, collectively called survey objects, can be managed in a comprehensive survey dataset. In addition to storing these objects, survey datasets can be used to update dependencies in a computation network as subsequent surveys are performed.

Survey datasets can be used to enhance feature classes with survey-awarements, allowing stored features to be associated with survey coordinates. If the GIS supports the notion of survey-aware feature classes, then the survey-based data can be used to automatically correct the locations of dependent GIS features.

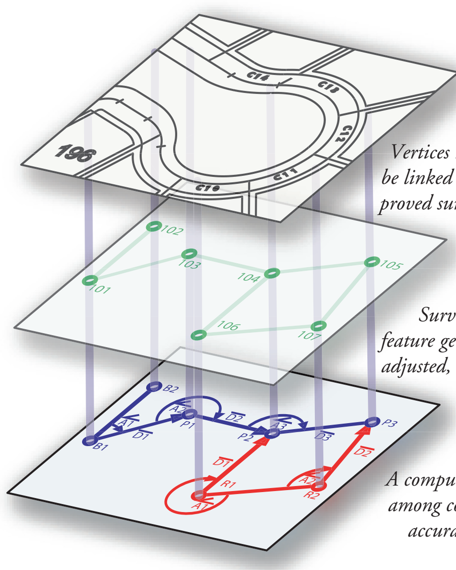
Today, a number of government agencies collect actual survey data as part of their routine workflow. This is expected to grow as the cost of making GPS-based surveys continues to drop, and to improve the quality of the parcel boundary information. The next step is to integrate these surveys within their traditional GIS data using survey datasets. Several progressive government agencies will begin to incorporate survey data into their information holdings to gain higher-quality parcel representations.

The chapter on the federal lands data model provides more examples and discussion of survey datasets.

Survey-aware feature classes

Feature class
Corner
Boundary
TaxParcel
SimultaneousConveyance
SurveyFirstDivision
SurveySecondDivision

Survey-aware feature classes can participate in a topology. In these cases, all of the topologically integrated feature classes should be survey-aware.



GIS geodatabase
feature

Vertices in survey-aware feature classes can be linked and optionally adjusted when improved survey point locations are calculated.

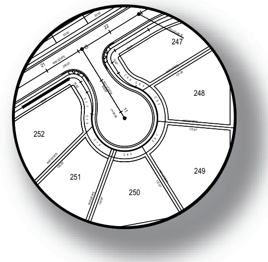
measurement database
survey point

Survey locations can be associated with feature geometry. When survey locations are adjusted, linked feature shapes are updated.

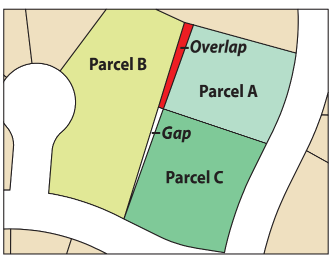
measurement database
measurement

A computation network stores dependencies among computations and refines positional accuracy with additional measurements.

You may have noticed that terms, such as continuous, noncontinuous, overlapping, and nonoverlapping appear numerous times in this chapter. These are important business rules and behaviors that can be enforced within the database using topology. Simply put, topology represents a set of spatial relationships that may exist between two or more features. These relationships include adjacency, intersection, overlap, and many others. Topology integrity rules are an important part of the GIS database definition.



Modern GIS software allows users the flexibility and ease of defining their topology requirements in terms of data integrity rules. This section presents the key topological rules that are applied in the parcel data model.



Tax and owner parcels are intended to be continuous and nonoverlapping. This does not mean they always are, but over the long term, errors tend to be corrected.

For example, the three parcels shown above have an overlap between Parcels A and B, and a gap between parcels B and C. The overlap and gap may due to ambiguous legal descriptions or incorrect mapping representation. Either way, this situation results in five ownership parcel polygons in the GIS. The polygon between parcels B and C may be coded as a gap or unknown ownership and the polygon between parcels A and B may be coded as an overlap or conflict. Alternatively, the shaded areas may be assigned to one of the adjoining owners. These are decisions that each jurisdiction will need to make in their parcel mapping programs. The parcel data model accommodates a wide variety of solutions to this situation.

Within this data model, several feature classes are expected to be topologically integrated, that is, to participate in the same topology. The rank indicates priority for movement of features during topology editing. For example, if a parcel feature were being added to a map, and a boundary feature already existed that was intended to form one side of the parcel feature, then the boundary feature's location would be considered a better reference than the parcel feature's location.

Given these ranks, the topological relationships between these features can be defined in terms of integrity rules, as shown next. Several different kinds of integrity rules are applied to the spatial relationships between the parcel model features.

Topology rules can be defined either *within* a single feature class or subtype, or *between* two feature classes or subtypes, and each rule essentially reads like a complete sentence. In this list, there are two kinds of rules *within* a single class: must not have dangles and must not overlap. Another common rule is must not have gaps, however, this rule is not used in this model because each of the feature classes is typically noncontinuous on a parcel map; that is, gaps often occur, such as at roads and other common areas. However, depending on your system and policies, you may find it useful to add this rule as well.

Topology
ParcelFeatures_Topology

Cluster tolerance *0.000247*

Participating feature classes and ranks

Feature class	Rank
Boundary	1
SimultaneousConveyance	2
SurveyFirstDivision	3
SurveySecondDivision	3
Encumbrance	4
TaxParcel	4
RegulatedUse	5
SiteAddress	5
TaxDistrict	5

Topology rules

Origin feature class	Topology rule	Comparision feature class
Boundary	Must not have dangles	
TaxParcel	Boundary must be covered by	Boundary
SimultaneousConveyance	Boundary must be covered by	Boundary
SurveyFirstDivision	Boundary must be covered by	Boundary
TaxParcel	Must not overlap	
SimultaneousConveyance	Must not overlap	
SurveyFirstDivision	Must be covered by	SimultaneousConveyance
SurveyFirstDivision	Must not overlap	
SurveySecondDivision	Must be covered by	SurveyFirstDivision
SurveySecondDivision	Must not overlap	

There are several more types of rules *between* feature classes in this list. The rule SimultaneousConveyance boundary must be covered by Boundary means that all sides of the exterior of a simultaneous conveyance polygon feature must coincide with a Boundary line feature. Another rule SurveyFirstDivision must be covered by SimultaneousConveyance means that wherever a SurveyFirstDivision polygon appears, it must fit within a separate SimultaneousConveyance polygon.

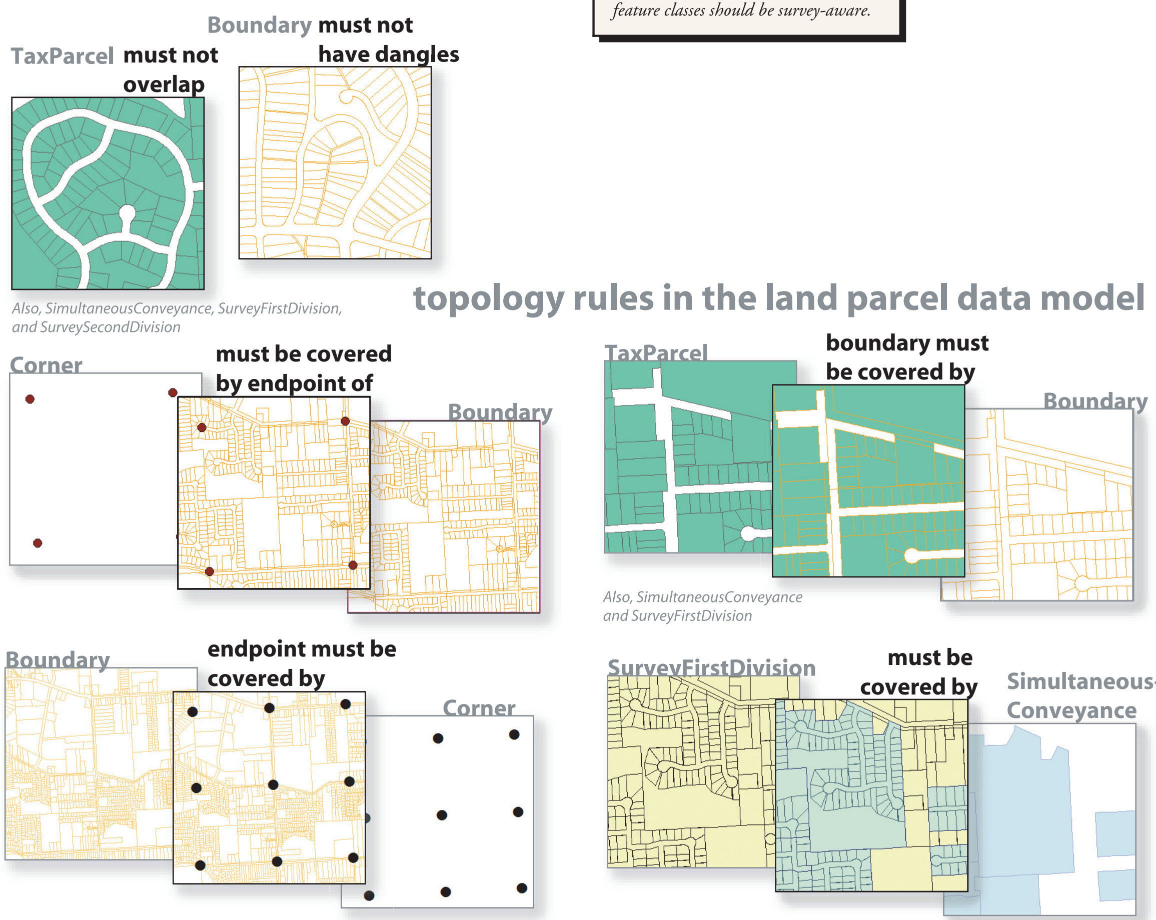
Notice that each rule is specific to the geometry types of the origin and comparison feature classes. For example, polygon features can be covered by other polygon features, but their boundaries would be covered by line features. Similarly, line features' endpoints would be covered by point features.

Topology rules could also be applied to site addresses. For example, SiteAddress must be properly inside TaxParcel and TaxParcel contains point SiteAddress. These are symmetric rules, to make sure that every parcel has at least one address, and every address is located on a parcel.

Survey-aware feature classes

Feature class
Corner
Boundary
TaxParcel
SimultaneousConveyance
SurveyFirstDivision
SurveySecondDivision

Survey-aware feature classes can participate in a topology. In these cases, all of the topologically integrated feature classes should be survey-aware.



Parcel model decision tree

This parcel model decision tree contains a progression of questions and steps to help you decide which elements of the parcel data model your agency needs. The parcel data model is a rich set of feature classes that cover many contingencies for a variety of jurisdictions. However, your agency may only require a portion of the parcel data model. This decision tree gives you guidance on selecting which of the feature classes you should include in your geodatabase. You can incrementally add feature classes as your project advances to meet your business requirements.

Do you build on and manage a parcel framework?

The parcel framework is the primary division of parcels used for parcel mapping and parcel reference. In the public domain states of the U.S., the divisions of the Public Land Survey System—township, section, and section divisions—form the parcel framework for mapping and legal descriptions. In other areas of the U.S., there may be municipal or town divisions with further divisions into map sheets or other regular divisions. For example, the State Plane Coordinate System may be used to define a mapping grid cell or the Tax Map Sheet (TMS) system may be used to define a grid or cell reference system. Most mapping jurisdictions will have some sort of parcel framework.

Because of the many variations in international parcel frameworks, the parcel data model does not model other systems. If you are outside the U.S., you should modify the parcel data model for your national requirements.

Do you manage survey information?

If you track and store distance, direction, source, and accuracy information about parcel lines from multiple surveys, then you are managing survey information.

You do not need to fully manage the measurements in a survey dataset in order to use parcel coordinate geometry and distance annotation on your parcel boundaries. In addition to managing the measurements between corners, you will probably manage information about the corners themselves, such as monument recovery notes.

Do you manage tax parcels?

Tax parcels are most commonly managed by counties and local governments. These are the parcels that have a related record in a tax or assessment roll and are used to support the tax assessment program.

Do you manage ownership information?

Ownership parcels may be used as the foundation to build tax parcels. Ownership parcels will, by definition, provide a spatial representation of all deeds and surveys. All the land in the jurisdiction will be accounted for in an ownership mapping program and it will be possible to generate chain of title information from the maps. In most U.S. counties, a typical land records system will begin with the tax parcels and could evolve to the ownership parcels.

Do you manage rights and interests in land?

The rights and interest in land are the individual components of ownership. These components are sometimes thought of as a bundle of sticks that can be separated. For example, the mineral rights are often separated from the surface rights. Are grazing rights and hunting rights tracked and managed within your system? If they are, then you probably manage rights and interests.

Do you manage data related to parcels at a local level?

Administrative areas are related to parcel information, such as school districts, tax districts, and municipal boundaries. These districts and administrative areas are often mapped based on parcel boundaries. For example, a school district might be defined by merging all of the parcels coded as being in that district. (This is called a dissolve operation in GIS systems.)

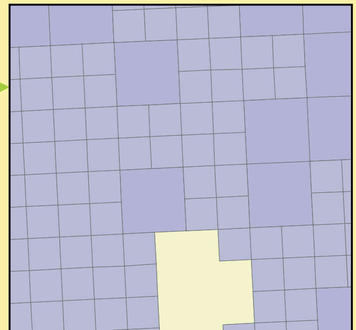
Sometimes these boundaries are drawn independently of the parcel boundaries, such as with many school district boundaries. When these districts are combined with the parcels, they help define the tax parcel characteristics. For example, a tax parcel boundary may be formed from the combination of the parcel boundaries and the school district boundaries so that no tax parcel is in more than one school district.

Parcel model decision tree

Do you build on and manage a parcel framework?

yes

Add parcel framework layers to your map



The typical custodian of the parcel framework is a county surveyor, county engineer, tax assessment office, or register of deeds.

no

Add these parcel framework feature classes to your geodatabase.

- Feature class **Simultaneous-Conveyance**
- Feature class **SurveyFirst-Division**
- Feature class **SurveySecond-Division**
- Feature class **PLSS-Township**
- Feature class **PLSSFirst-Division**
- Feature class **PLSSSecond-Division**

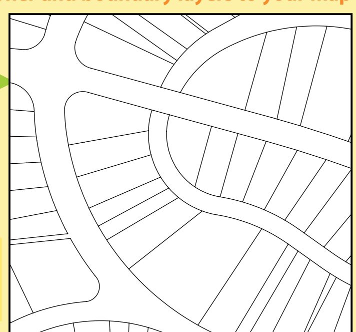
Generally, if you have any hierarchical or nested legal descriptions, the highest level of description will form a framework. The framework may not cover your entire jurisdiction and you may have a mix of parcel feature classes in your jurisdiction.

The U.S. Public Land Survey System is a familiar parcel framework in the 33 public domain states, but the metes and bounds states also have frameworks based on subdivision boundaries, municipal boundaries, and other references established to control surveys and legal descriptions.

Do you manage deed or survey measurements?

yes

Add corner and boundary layers to your map



In the U.S., this task is commonly done by county surveyors, engineers, and register of deeds.

no

Add these corner and boundary feature classes to your geodatabase.

- Feature class **Corner**
- Feature class **Corner-Coordinate**
- Feature class **Boundary**
- Feature class **Monument**

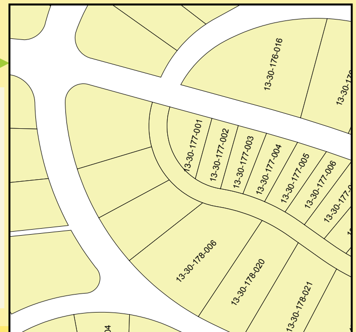
An alternate reason to include these model objects is to show boundary annotation on the parcels.

The monument information may be managed as imaged records of notes and filings from land surveyors. Monuments are helpful in determining which point is the endpoint of a line when constructing coordinate geometry from deeds.

next page

Do you manage tax parcels?

yes → Add tax parcel layers to your map



The typical custodians of tax parcel data are real property listers, cadastral mappers, property mappers, real estate or auditor offices, or GIS staff. This data is used to present a map of the taxable and taxed land in your jurisdiction. Most counties and cities manage tax parcels.

You will probably want to link your tax maps to your tax roll or your assessment roll. You may also want to have snapshots of your database at the end of each tax season for archive and reference.

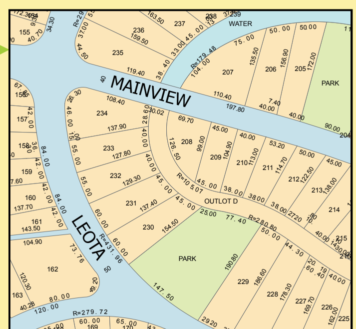
Add these tax parcel feature classes and relationship classes to your geodatabase.

- Polygon feature class **TaxParcel**
- Relationship class **TaxParcelHasCondos** (One to many)
- Table **CondoRelate**
- Relationship class **CondoHasTaxRoll** (One to many)
- Relationship class **TaxParcelHasTaxRoll** (One to many)
- Table **TaxRoll**

no ↓

Do you manage ownership information?

yes → Add ownership parcel layers to your map



The landownership custodians may be the same as the tax mapping custodians but may also be register of deeds, county engineers, county surveyors, or large landholders managing their holdings, such as the Bureau of Land Management or the U.S. Forest Service. One of the tests for if you manage ownership is, do you account for all the land in your jurisdiction and do you track all of the changes in ownership throughout the year.

The parcel owner may be updated from the parcel reference, perhaps a database generated from the deed or other purposes and track the percent of interest owened separately. You may also want to link ownership to other actions on the land-like mortgages. This would be done by linking to a related table.

Add these ownership parcel feature classes and relationship classes to your geodatabase.

- Feature class **OwnerParcel**
- Relationship class **OwnerParcelHas-Owner** (Many to many)
- Table **Owner**
- Relationship class **OwnerParcelHas-Condominium** (One to many)
- Table **VerticalParcel**

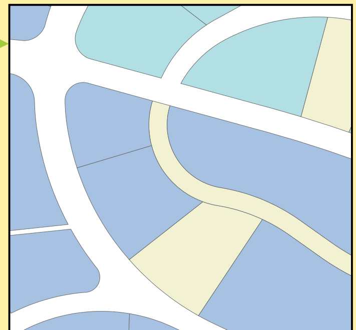
no ↓

next page

Do you manage rights and interests in land?

yes

Add rights and interests layers to your map



Typical custodians are large landholders and land management agencies, such as state landownership management agencies, the Bureau of Land Management, and the Forest Service in the U.S. Some local governments may include encumbrances, such as utility easements on their tax parcels, but most local governments do not map and manage mineral rights.

Add these rights and interests feature classes and relationship classes to your geodatabase.

Feature class **Separated-Right**

Relationship class **RightsHave-References**

Many to many

Table **ParcelReference**

Feature class **Encumbrance**

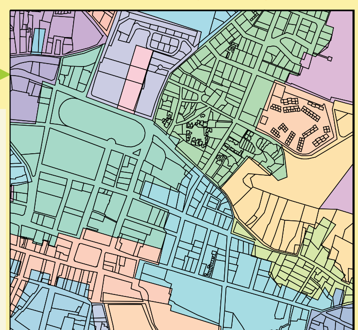
The domain of values for the mineral types will vary depending on what is commonly extracted or separated in your area. Likewise, the indication of the type of easement will depend on what most commonly occurs in your area, for example, utility, ingress/egress, and conservation are three commonly mapped easements.

no

Do you manage data related to parcels at a local level?

yes

Add rights and interests layers to your map



These are the districts and administrative areas that may either be derived from the parcel or map, form a defining limit for parcels, or define the authority or jurisdiction for parcel information. This category also includes map sheets, such as tax map system indices.

Add these tax parcel feature classes and relationship classes to your geodatabase.

Feature class **SiteAddress**

Feature class **RegulatedUse**

Feature class **Restriction**

Feature class **TaxDistrict**

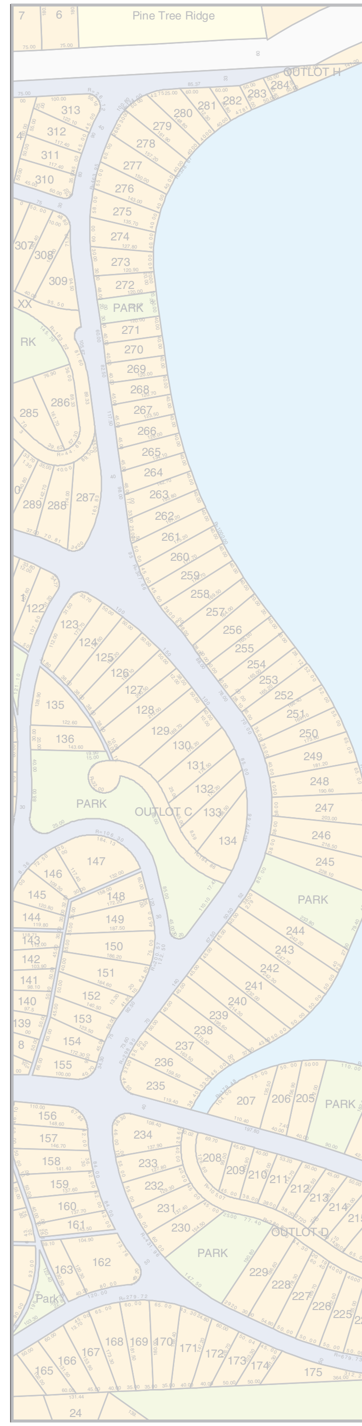
Feature class **MapIndex**

This information is usually managed by the same group that manages the parcel, either ownership or tax, and is often used by a wide variety of applications. For example, school districts might affect and be managed by the real property tax manager, but may be important for school bus routing and demographic information.

no

finish

In the US, local governments maintain a series of standardized parcel maps to cover a sizeable geographic area at large map scales. The map shown here illustrates many typical parts of a parcel map.

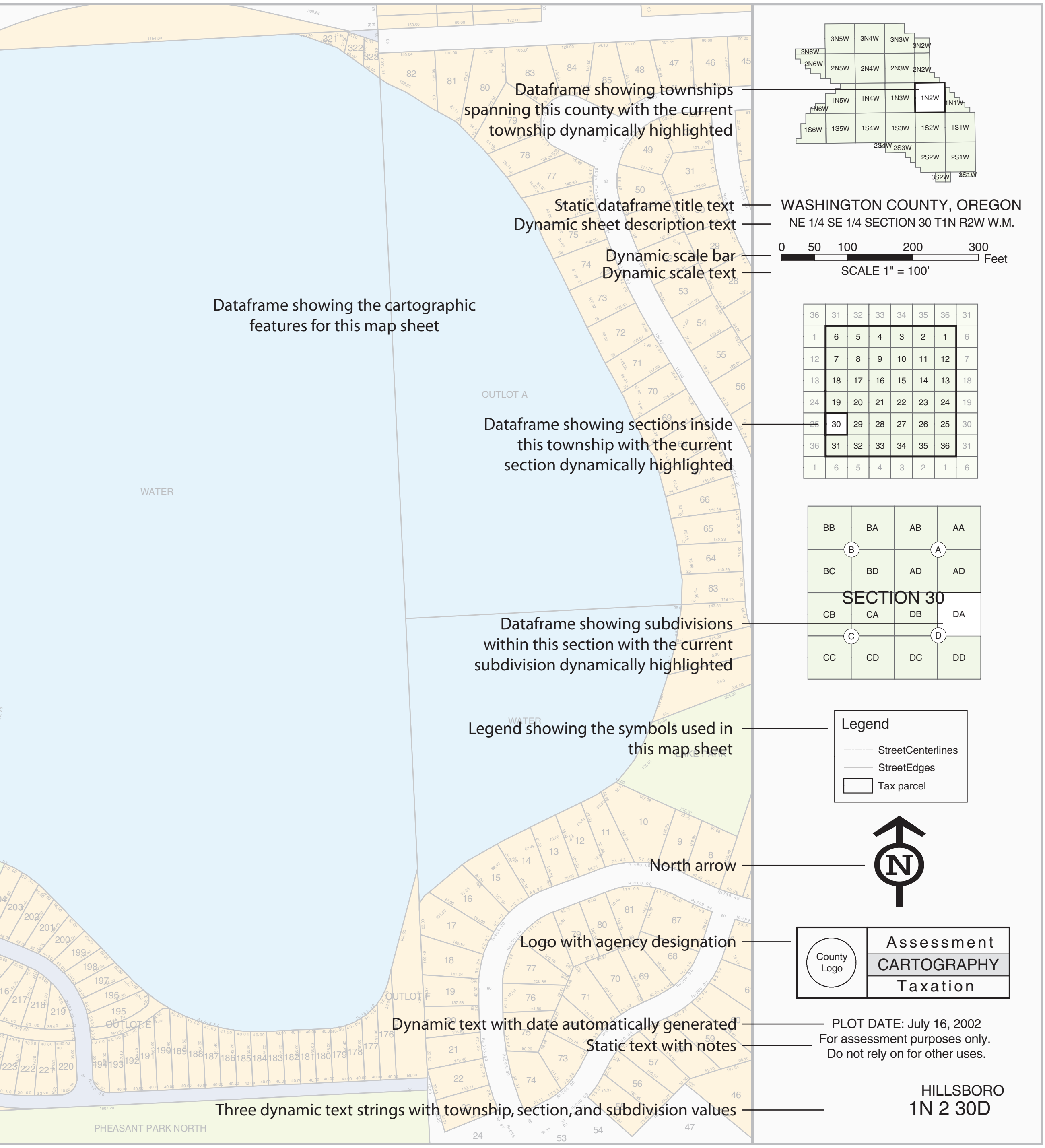


CADASTRAL AND LAND RECORDS MAPPING

Government agencies need to create map sheets of all of the parcels in their jurisdiction, at multiple scales. Every parcel must be shown whole on at least one sheet, if possible.

Some counties still maintain a deed book and page hardcopy of their parcels. The boundaries for these areas are irregular and somewhat arbitrary. However, there is a need to be able to plot parcel maps based on the deed book and page boundaries. In many cases, the map pages often form the polygons of a map index layer, which is used in tax map production. This is the intent of the MapIndex feature class.

Some counties and cities provide tax assessor maps to the general public. These maps are included in some large-scale map series. You can come up with a number of different variations of the content but the reason for the series remains the same—to regularly print on paper the extent of the municipality at large scale. Some example data include cadastral base maps, zoning maps, emergency fire hydrant maps, and water/sewer/storm infrastructure maps.


Dataframe showing townships spanning this county with the current township dynamically highlighted
Static dataframe title text
Dynamic sheet description text
Dynamic scale bar
Dynamic scale text
Dataframe showing the cartographic features for this map sheet
Dataframe showing sections inside this township with the current section dynamically highlighted
Dataframe showing subdivisions within this section with the current subdivision dynamically highlighted
Legend showing the symbols used in this map sheet
North arrow
Logo with agency designation
Dynamic text with date automatically generated
Static text with notes
Three dynamic text strings with township, section, and subdivision values
WASHINGTON COUNTY, OREGON
NE 1/4 SE 1/4 SECTION 30 T1N R2W W.M.
0 50 100 200 300
Feet
SCALE 1" = 100'
SECTION 30
Legend
StreetCenterlines
StreetEdges
Tax parcel
County Logo
Assessment
CARTOGRAPHY
Taxation
PLOT DATE: July 16, 2002
For assessment purposes only.
Do not rely on for other uses.
HILLSBORO
1N 2 30D
OUTLOT A
WATER
OUTLOT E
OUTLOT F
PHEASANT PARK NORTH

Accessing the history of the parcel fabric

Parcel maps and parcel information in databases are continuously updated over time. Real estate transactions, parcel splits, and new subdivisions occur almost continuously. This section describes a number of approaches for tracking historical parcel information in the database. The three types of parcel history tracking described here are snapshot, periodic, and transactional. Examples are also given of historical queries that can be used with such databases.

METHODS OF HISTORICAL TRACKING

The historical parcel representation described here refers to the spatial representation of parcel history. Parcel maps and parcel information in databases are often outdated as soon as they are collected.

There are several parcel history tracking options that varying jurisdictions employ. (*ESRI, 2002*)

- Some jurisdictions may keep the most current representation of ownership parcels on their maps and in their databases and are not concerned with past representations.
- Others may keep periodic snapshots, such as monthly, quarterly, or yearly views of parcel information, as it existed at that time.
- Still others track the transactional changes and maintain a record of all changes in ownership and geometry.

These tracking approaches are most easily handled with an appropriate *version management system* in the GIS database. In this context, a version represents the contents of a database at a specific point in time. The versioning model maintains past and present representations of modified or deleted features, and the time that these features changed, without requiring the user to manage special layers or date stamps on the features. To understand how this capability is used, it serves to present two history management concepts: change events and temporal granularity.

A *change event* in a versioned database is what moves the database from one point in time to another point in time. In the example of a parcel ownership database from 1990 to 2001 and beyond, the change events could be the occurrence of countywide property reassessments, or any updates to the instruments (a deed, subdivision plat, and so on) that record ownership or other policy-driven events.

The *temporal granularity* is the frequency between change events. Historical records can be recorded at the finest granularity, based on individual database transactions, or records can be aggregated or summarized to broader time periods, such as at weekly, monthly, or annual intervals.

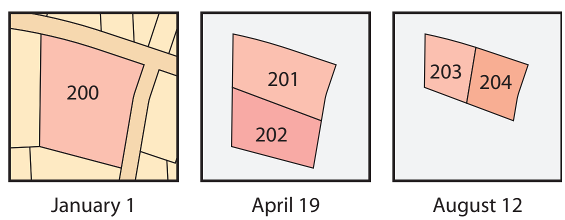
By choosing the appropriate change events and temporal granularity for an historical database, any of the tracking options mentioned above can be achieved.

In addition, regardless of the use of a version management system, database snapshots can be made at any time.

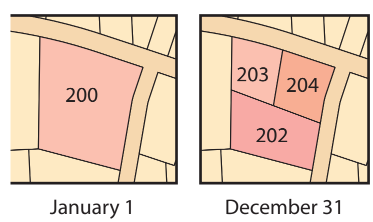
ARCHIVAL SNAPSHOTS

A database snapshot is created by archiving the database at an appropriate point in time. The snapshot is used as the public or official view of the database until the next snapshot is made. Over time, these snapshots can be used to analyze changes in assessment patterns or for other research purposes.

This type of historical information does not track intermediate changes that occur between the snapshots. For example, a property could change hands several times during a year, as shown in the first figure below.



However, only the starting and ending owners would be captured in the archive, such as shown in the next figure.



Local governments often create snapshots once or several times a year to match their tax or assessment roll. With a versioned database, once all of the edits are made to the parcel data for the current snapshot period, the snapshot is made by simply creating a version of the database for that snapshot. This version then serves as the official assessed parcels view of the database that is used by all GIS users outside the assessment office until the next snapshot. In the absence of versioning, a complete copy of the database would be made at the appropriate time, and archived.

TRANSACTION TRACKING

The finest granularity in which history can be recorded is at the transaction level. In this approach, a change event is created for each database transaction. In a parcel database, an historical version could be created every time a parcel or group of parcels are created, modified, or deleted. In this case there is typically some type of instrument, such as a deed or subdivision plat, that causes the change. This instrument is the change event.

This type of historical information keeps the complete history of changes in the database and the parcel maps in chronological order. This transactional history keeps the chain of title as well as geometry changes. The current ownership is determined from the most recent set of transactions.

This approach supports spatially enabling a parcel management system. It leads to full reconciliation with all aspects of the life of each parcel.

PERIODIC HISTORY TRACKING

Periodic historical tracking is an intermediate approach between making snapshots and tracking all transactions. This could be used to document the changes from a known point in time, such as from the beginning of each quarter or year. With a version management system, transactions could be aggregated to the user's desired interval, such as quarterly or annually. Without version management, users could maintain a working file that contains only the changes made from a known point in time. The changes may then be kept as a separate archive at the end of the year, or may be combined with the information that didn't change to create a new year-end version.

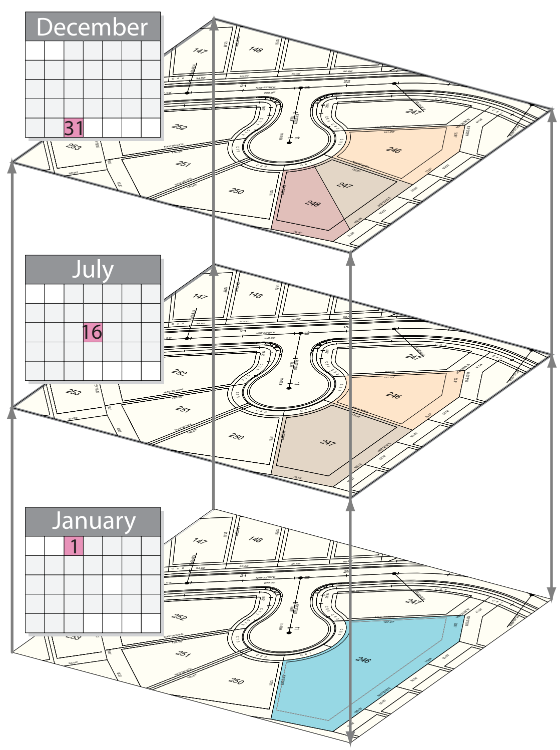
If the periodic changes are in a versioned database or kept as a separate file, there is a greater chance of retaining intermediate changes that occurred during the year. However, it is possible that the periodic archive may not be fully reconciled; that is, intermediate parcels may lack complete attribution.

HISTORICAL QUERIES

Once a versioned historical database has grown to include a significant number of versions, it opens up the potential for history-based queries, such as:

- Show me the database at "January 1, 2002".
- Show me how parcel feature "1234" has changed through time.
- Show me what is in the space of feature "5678" at "April 15, 2002".

In designing the database versioning to support queries like these, it is important to keep in mind who should have access to the historical data. For example, public access may be allowed to snapshot data but not to transaction data.



SUMMARY

This chapter has presented several aspects and issues of parcel data modeling for land management. Starting with general workflow and user requirements, the conceptual model of thematic layers was presented. From this, a logical model of feature classes and feature class collections was developed.

The discussion of feature class groupings started with Corners and Boundaries because these underlie both the larger parcel frameworks, such as PLSS, and the smaller parcel frameworks, such as simultaneous conveyances. Following these foundation feature classes, Tax Parcels, Ownership Parcels, Parcel-related uses, Administrative areas, Raster and Survey datasets were discussed in turn.

This was followed by a decision tree to help the reader determine which feature classes are appropriate to include in their particular model.

Special topics, such as topology rules, parcel cartography, annotation, and history tracking, were grouped at the end.

Land management policies and systems vary considerably around the world. The parcel data model was developed by a guided consortium of industry and agency experts over a period of a few years, with the intent of directly supporting, or being easily extended to support, any cadastral requirements.

By choosing a particular case study, in this case Oakland County GIS in Michigan, USA, most of the key concepts could be introduced that other agencies would choose from, according to their unique needs.

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CREDITS

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FURTHER RESOURCES

Data models URL at ESRI ArcOnline: follow Land Parcels link from *http://support.esri.com/datamodels*.